Computer Augmented Reality Model-Based Interactive Teaching System for Chinese Line Drawing CAD

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ABSTRACT

To achieve automatic target region detection, an interactive image segmentation technique has been always used as preferences. However, when it comes to the implementation of computer aided design, there is a problem with the structured method. The technique of stroke contour extraction based on boundary detection is used in this investigation. The high-frequency lifting filter improves the original image, and the grey scale and spatial distribution of the pixels are used to determine how the pixels are distributed on the pen track. The segmentation of mural lines and strokes is achieved well in a limited space. To ascertain each pixel's grey value distribution, a non-realistic rendering technique is suggested. Draw in accordance with the boundary tangential flow and each pixel's category. In conclusion, the two approaches can cover more application scenarios and yield good results in the extraction of creative materials from Chinese classical mural painting while maintaining the entire shape of the original strokes in the painting.

INTRODUCTION

Line painting takes line as the main body, which is not only an art form (Zainal Abidin et al., 2008), but also a basic element to form visual image (Abidin et al., 2011; Akner-Koler, 2000). In most cases, it is related to intuitive thinking (Toyong et al., 2021). The extraction of the line depiction of the mural can not only help us better understand the existing shapes and images, but also help us apply these traditional elements to industrial design and create new forms and images (Tovey, 1997; Vihma, 1995). The traditional boundary detection algorithm based on Canny, such as the Canny operator, can extract the image boundary effectively (Li & Liu, 2022). However, because the line drawing of the mural is fixed, and the change of its width can reflect the artistic characteristics of the mural, when using this operation for line drawing, it will cause reactions on both sides of the stroke, resulting in a stroke associated with two edges (Jamaludin et al., 2013; Mohamed Kamil et al., 2018).

The global boundary probability detection operator (gPb) has high precision and can only extract a single boundary for some small strokes, but it has some disadvantages such as single pixel width and weak continuity. In the absence of bone feature extraction, the stroke size obtained by gPb operator can reflect the stroke size, but cannot extract the stroke well. The Gaussian filter divides the mural into several closed Spaces of similar colour and texture, so the line strokes are often cut off to form a separate space from the local background, thus adding additional boundaries (Li et al., 2021). The closed region generated by gPb-owt-ucm algorithm is segmented by the boundary segmentation algorithm based on Canny operator, which effectively overcomes the defects of the traditional boundary detection algorithm. In this project, the high frequency ascending filter is used to simplify the mural background, and the edge extraction and threshold segmentation are combined to automatically extract the line strokes. The diversity of media and the discipline have enabled artists to explore more media when producing creative artworks. These collaborations have expanded to produce new findings and allow new perspectives on disciplines in art (Michael & Rahman, 2021). Therefore, we need more forms of comprehensive art expression. The advantages of hybrid art practice forms can play a greater art (Michael et al., 2017; Goel, 1995).

LITERATURE REVIEW

Initial Drawing of Line Strokes

A. High Frequency Bandpass Filter

The working process of our method is shown in Figure 1 (image cited in Filtration Techniques for Surface Texture). There is a certain degree of certain overlap in the whole area. Therefore, this project proposes a Gaussian fuzzy fast-rising filter to realise the automatic segmentation of the stroke points in the original mural, and achieve a good contrast between the stroke and the background. The Gaussian low-pass filter is given by formula (1).
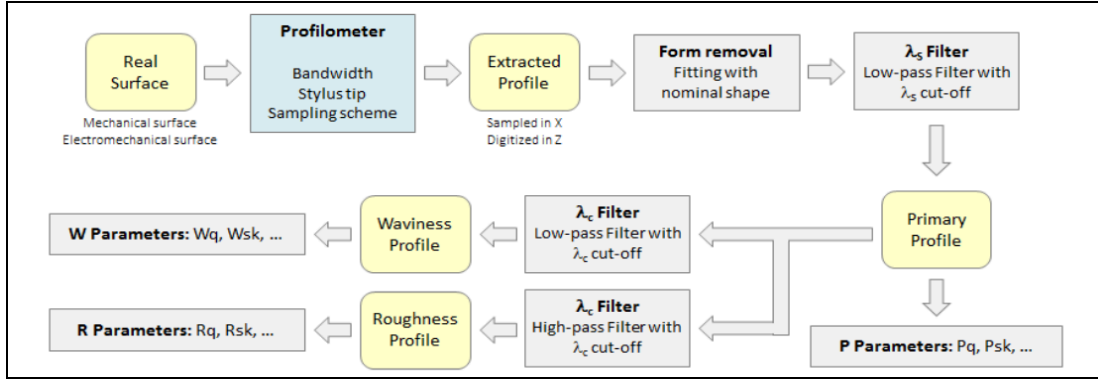
Figure 1. Flow of gaussian filter algorithm
(Source: Author's collection)

$$R(\alpha,\beta) = e^{-dist^2(\alpha,\beta)/2\varepsilon^2} \tag{1}$$

$dist(\alpha,\beta)$ is the Fourier transform. ε is the distribution curve. When Fourier transform is applied to an image, the low frequency component can reflect some fine features in the image, such as boundary and noise. The grey distribution of stroke points and background points is well preserved, and the boundary of strokes is also preserved. The high-frequency lifting filter used here is represented by formula (2).

$$W_2(u,v) = \min(255, W_0(u,v) + \Delta W_0(u,v)) \tag{2}$$

W_2 is the output result. W_0 is the grey level of the original mural image. W_1 is the result of W_0 Gaussian ambiguity. The radius of the Gaussian kernel is denoted as r_g.

$$\Delta W_0(u,v) = \begin{cases} 255 & W_1(u,v) = 0 \\ \dfrac{255 - W_1(u,v)}{W_1(u,v)} g W_0(u,v) & W_1(u,v) \neq 0 \end{cases}$$

*B. Threshold Segmentation Method for Extracting Line Trace*

After high-frequency lifting filtering, the overall grayscale of background pixels is larger than that of stroke pixels, and pixels with higher grayscale values are more likely to appear in the background. Therefore,this paper uses Otsu method to perform threshold segmentation on filtering result W_2 and remove pixels with high grayscale levels (Fan, 2021). The threshold segmentation results are denoted as W_3 is shown in Figure 2.
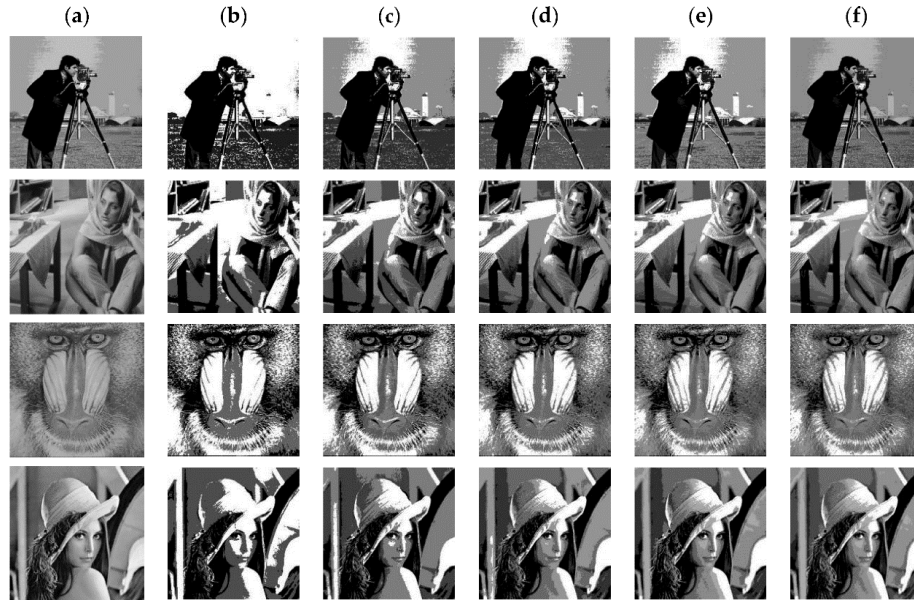
Figure 2. Threshold segmentation line trace
(Source: Author's collection)

C. *Optimization of Line Strokes with Boundary Extraction Method*

Based on the grey histogram of point A in the original image, the points in the image are discriminated, which leads to the discontinuity of stroke points. Stroke continuity algorithm based on Canny operator is proposed (Xu et al., 2023). In order to improve the consistency of the trip, this article follows the following steps:(1) Canny is the original grey-scale picture. The small threshold is denoted, the large threshold is denoted, and the result is denoted. (2) Use formula (3) to extract the outline of the pen path, and the result is denoted as. (3) is a pixel in the neighbourhood of 8. If the grey value of the pixel in is less than 255, and there is an edge pixel in the neighbourhood of 8, then the pixel is more likely to be located in the pen trace can control noise and affect pen integrity. When results are shown in Figure 3.
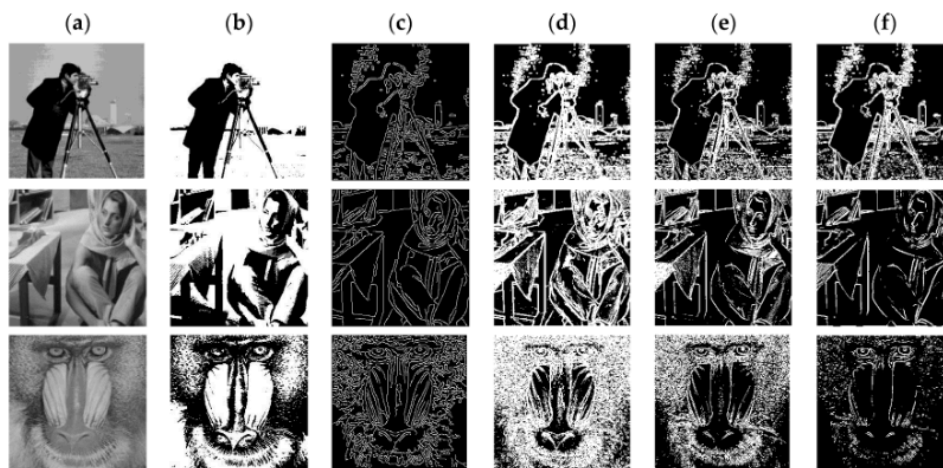
Figure 3. Results of optimising line strokes based on edge detection method

(Source: Author's collection)

D. Generation of Complete Line Trace

In the result $W_3^{'}$ generated based on edge detection, the pen path continuity is good, and the pixels whose grey value is close to the pen path in the background are eliminated, while the pixels in the pen path that are far away from the pen edge are also eliminated (Liang et al., 2023). In this paper, W_3 and $W_3^{'}$ are superimposed by formula (4) to generate a complete line tracing W_4.

$$W_4(u,v) = W_3(u,v) \& W_3^{'}(u,v)$$

RESEARCH METHODOLOGY

This research study uses the Design Research Methodology (DRM) framework which is a systematic methodology that it preferably practises in a product design and it place under the engineering design research platform (Blessing & Chakrabarti, 2009); due to featuring the synthesis of qualitative and quantitative data.
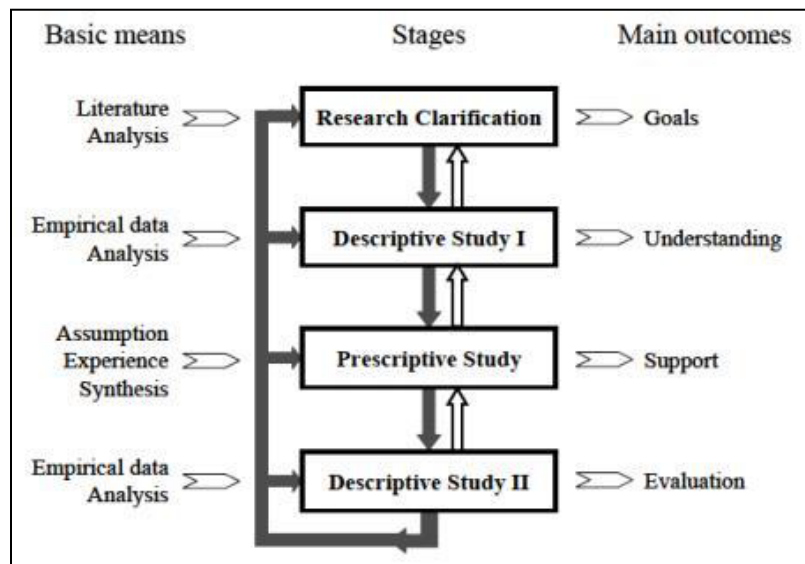
Figure 4. Design Research Methodology (DRM) framework flow
(*Source: Blessing and Chakrabarti, 2009).*

In Figure 4, the bold grey arrows represented the major sequence processes into each stage individually. It began from the research clarification (RC) – descriptive study I (DS-1) – prescriptive study (PS) – descriptive study II (DS-2) until the direction of sequence processes cycling, returning together into the four stages respectively. For the iteration review, the white arrows had vertically moved

from the bottom to upper , representing the quality of key factor evaluation increasingly revealed by the DS-2 stage. Then, it is transitively being stepped up to reach the support as evidence of PS stage to convince the understanding of DS1 stage. Lastly, the researcher will be reached or referred the goals research setting in RC stage as known as the problem statements, RO, RA and RQ's supposed to be fulfilled in the DRM ways systematically. (2) The first phase, which is the literature review, is a critical component of any research project.

During this phase, the researcher conducts a thorough review of existing literature in the field of study to identify relevant research gaps and determine research objectives. This involves an exhaustive search for relevant research articles, books, and other sources of information related to the research topic. By reviewing existing literature, the researcher can gain a comprehensive understanding of the research area, identify the key challenges or issues, and formulate problem statements that guide the research process.

The second phase involves the construction of interviews and questionnaires that will be used to gather data from subjects. The researcher needs to design appropriate interview questions and survey items that will allow them to collect the necessary data to answer their research questions. The design of these instruments requires careful consideration of the research objectives and problem statements formulated in the first phase. The instruments should be constructed in a way that allows for the collection of both quantitative and qualitative data to provide a comprehensive picture of the research topic.

RESULTS AND DISCUSSION

Interactive Platform for Cad Drawing Experiments

Components of the System

Aiming at the design objectives and problems to be solved of the interactive platform for CAD drawing experiments, the design system platform composition (Figure 5 is quoted in EEG-based analysis for pilots' at-risk cognitive competency identification using RF-CNN algorithm). The system consists of 4 modules: student client, file server, Zoo Keeper collaboration component, and teacher client.
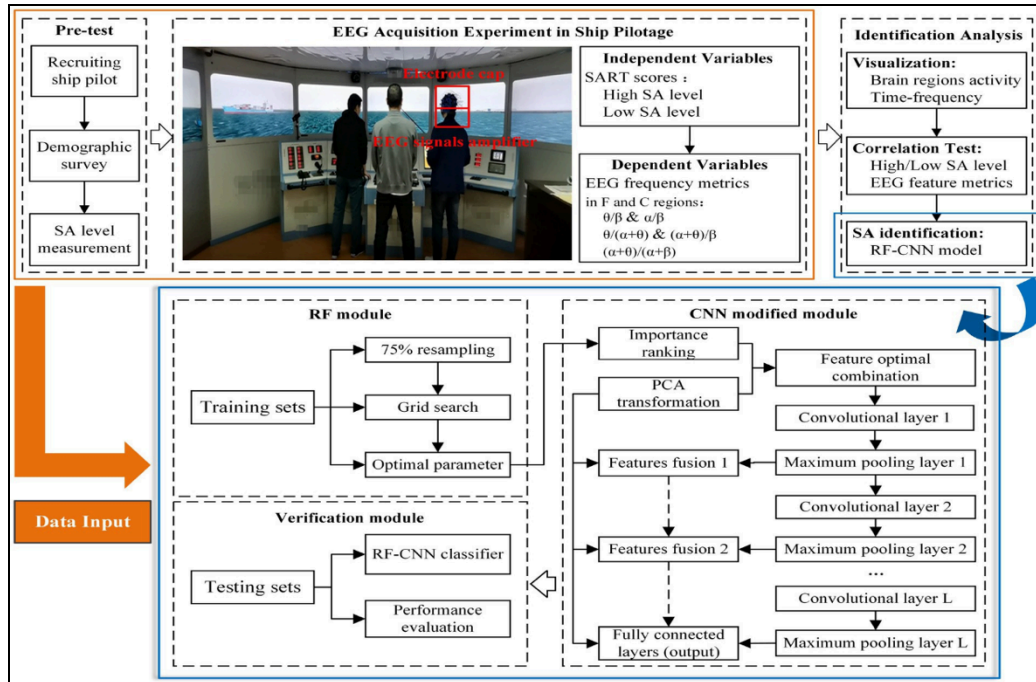
Figure 5. Composition of the CAD drawing experiment activity platform system
(Source: Author's collection)

Student Client

"Student User" means all system components installed on the student computer. The system can be used on the special microcomputer provided by the CAD laboratory or the microcomputer configured by oneself. The module consists of two main modules (Figure 6 cited in Providing Expert Advice in the Domain of Collaborative Scientific Inquiry): CAD system software for trainees to carry out operational training. The system is a comprehensive interactive platform for drawing teaching, which puts forward its own requirements for the selection of CAD software. It can either be built in or extended to realise the automatic storage of documents and the merging of document items. If the existing software device meets this requirement, there is no need to install special CAD software. A file monitoring sync element has been installed on the computer. The monitoring synchronisation element is a self-operating, separate software process that is installed on a student's computer. This widget automatically executes when the system is turned on and is timed with the Zoo Keeper collaboration widget to get system Settings, teacher tasks, backup tables of student drawing files, and more. At the same time, it can also monitor the automatic storage directory of student homework files in advance, periodically scan the files in this directory, if the file has been updated or the file size has changed, then it will back up the file as a suffix, and then upload it to the file server. During this process, you can set the file update threshold and determine whether it is necessary to back up files to the file server based on the file update interval and file size changes. This method can not only maximise the preservation of the student drawing process, but also reduce the synchronisation frequency of the data.
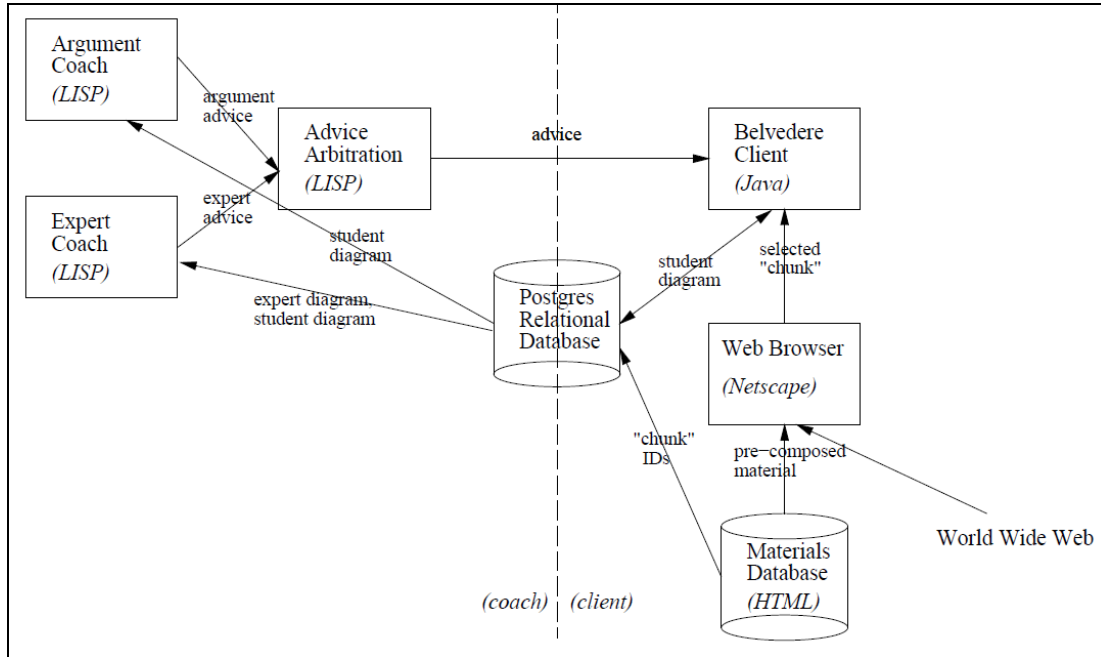
Figure 6. Student user component
(Source: Author's collection)

File Server

File server is used to store student drawing files, teacher information and other shared files. The teacher will send the file storage directory to each student according to the experimental status of the student, and each student's file will be uploaded to a specific file bag at the same time, so that the teacher can check the progress and other students in the group can check. When the students jointly draw a more complicated chart, the student's client will download the chart of other students, and then make it on the computer, so that students can understand the progress of the whole chart.

Apache Zoo Keeper

Apache Zoo Keeper is an open source, extensible, efficient, extensible, and runs on top of Apache. It supports consensus mechanisms, group management mechanisms, and leader election mechanisms, and can be used to configure service components, synchronise service components, or specify registration components. Name Service is a service that associates names with associated connection information. Just as a phone book maps a name to a cell phone number, a DNS maps a domain name to an IP address. By using names, you can track the associated members of one or more clusters. Zoo Keeper supports distributed mutual exclusion in an easy way to ensure that data is consistent between shared resources and that it is properly updated. In a distributed network, effective configuration management is an important guarantee to ensure its normal operation and expansion. Through centralised storage and management of Zoo Keeper, the openness of the system is ensured. After a new compute node is connected to the system, it can quickly obtain the corresponding configuration information from Zoo Keeper, so as to realise a change in the entire distribution system. Zoo Keeper uses a leader selection mechanism to ensure that an outage in one cluster does not disrupt business throughout the cluster.

Faculty Client

In addition to similar features to the student client, the system also provides task management components (Zoo inspectors). All data modes in Zoo Keeper are a tree, just like the file directory in Unix. Task Manager is the data maintenance interface for Zoo Keeper, and it can check the current data and make changes to it by linking to the corresponding Zoo Keeper. In Zoo Keeper, teachers use task management components to store backup files for each student, determine learning materials and shared files, and work in groups according to the student's academic level.

Line Drawing CAD Platform Implementation

Line drawing CAD macros allow users to customise specific features and load them into the system. The self-defined automatic document storage and document fusion. Under normal circumstances, the teacher can check and modify the drawing of students, but due to time constraints, the teacher cannot draw for each student. The automatic storage of the file is to record the entire process of painting. The teacher can browse the file of painting at will, know the progress of painting by comparison, and find out their own problems. If necessary, you can open more image files to see the details in more detail. Splicing several smaller pages into one, so that students at a glance. Line drawing CAD also provides a document that can be combined with other engineering documents and projects that are now open. The platform also develops and implements a synchronisation component of document monitoring, and makes a preliminary specification for it. In this system, each user can obtain relevant configuration information through Zoo Keeper, and can update the node tree structure. The system consists of three main modules: configuration and practice files, group data and student data. Using the interface of "Task management module", the teaching objective is adjusted. Each student's profile contains the address of the file on the server, the group to which it belongs, and the trial requirements. In order to facilitate the teacher to teach, in the experiment, each student can carry out a variety of homework or group homework. Users can browse to the left to enter the relevant documents, after comparison, you can quickly find the problems and correct, and line drawing CAD itself all operations are carried out in the way of instructions, that is, each action on the interface will have a corresponding instruction. For example, click on the menu, add nodes, change the display scale, move rows, and so on. These instructions are displayed on the console and can be used repeatedly. The students in the same group can easily share the instructions when interacting, so that the students who participate in the discussion can clearly see the relevant procedures and order, and summarise and grasp the key points through watching and discussing the work process of other students.

CONCLUSIONS

Using the techniques of image boundary extraction and threshold division, the algorithm of line drawing for mural painting is studied. Whether it is a figure painter or a landscape painter, their works are full of pain and ups and downs. They are all kind -hearted and feel that they are driven by emotions. The lines are painted, or they are deep and simple, or light and soothing. Therefore, the lines that cause beauty in Chinese painting are not only an abstract summary of objective objects, but also a tangible carrier that expresses subjective emotions in the art of painting. It not only clearly expresses the painter's full emotions, but also produces poetic and artistic rhythm and rhythm. All in all, whether it is figure paintings, landscapes, flowers and birds painting, the lines of shaping the image have played its unique role. Although through thousands of years, the master of painting has continuously created and enriched the performance skills of lines in practice, making the shape of the lines more fully and perfect. The stroke point in the image to a certain extent, and keep the original style of the mural. Using the interactive platform of CAD drawing experiments help each other, help students make appropriate learning plans,

check the progress of students, and provide targeted guidance, which can be easily integrated into students, so as to establish a good relationship between teachers and students.

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