Intelligent Online Medical Annotation Platform Design and Implementation

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Abstract: There are several challenges in the field of medical image annotation, including stringent annotation standards, high workload, and significant inter-annotator differences. Additionally, the rapid growth of medical image data in China, driven by advancements in the medical industry and the Internet, has posed significant challenges for the annotation process. The increased volume of data has resulted in a doubling of work pressure for annotators and has indirectly affected patient treatment. To address these issues, the project aims to integrate internet technology with annotation tasks, enabling fast and cost-effective labeling. The platform's distinctiveness lies in its integration of internet technology with annotation tasks, providing a fast and cost-effective labeling solution. By leveraging intelligent labeling algorithms, we aim to alleviate the workload of doctors and facilitate efficient and accurate annotations. Our primary objectives include addressing stringent annotation standards, reducing the high workload, and bridging the inter-annotator differences. The platform's key solution focuses on combining efficient labeling methods with internet accessibility, thus presenting a promising approach to the challenges encountered in medical image annotation.
***Keywords*:** Medical image annotation; Internet; Intelligent annotation; Platform

1. Introduction

In the realm of medical image annotation, challenges arise due to the rigorous annotation standards, demanding workload, and substantial disagreements amongst annotators. Meanwhile, the medical industry and the Internet's advancements have led to a remarkable 30% annual growth in medical image data in China. The surge in data volume has posed significant difficulties in the annotation process, thereby doubling the work pressure on annotators and subsequently impacting patients' medical treatments.

To address these issues, we have conceptualized and developed an intelligent online medical annotation platform in the form of a webpage. This platform enables doctors to annotate medical images at their convenience, allowing for remote imaging diagnosis. Furthermore, it incorporates AI-assisted doctor diagnosis, which extends beyond a single algorithm implementation on the platform. This integration enhances the accuracy and practicality of medical treatments, offering improved outcomes in patient care.

2. Background

The inherent annotation function within the PACS (Picture Archiving and Communication System) facilitates doctors' diagnoses and enables better explanations of medical conditions to patients. However, traditional PACS systems have several limitations that need to be addressed. Firstly, these systems are primarily designed for image storage and retrieval, providing limited support for medical image annotation functions. Secondly, the annotation process in traditional systems relies heavily on manual operations, which can be time-consuming and prone to human errors. Thirdly, due to the rapid growth of medical image data, traditional PACS systems face significant pressure and challenges in terms of annotation workload. Relying solely on manual annotation is no longer sufficient to meet the demands for high-quality and efficient annotations.

Therefore, there is a pressing need for a new online medical annotation platform to overcome these limitations. The new platform can leverage internet technology and intelligent annotation algorithms to automate and streamline the medical image annotation process. This approach can significantly reduce the workload for healthcare professionals while improving the accuracy and efficiency of annotations.

Existing platforms are unable to meet these requirements mainly because they often lack robust intelligent annotation capabilities and efficient automation workflows. Manual operations in traditional platforms are prone to errors, and as the volume of medical image data increases, the manual annotation workload becomes overwhelming and difficult to manage. Additionally, subjective and inconsistent annotation results can be a challenge, leading to discrepancies that could impact patient treatment and clinical decision-making. Therefore, a new online medical annotation platform is needed to meet high annotation standards and provide efficient and accurate annotation results, ultimately advancing medical research and

clinical practices.

3. Intelligent online medical annotation platform

3.1 System structure diagram

The "Suizhu" intelligent online medical annotation platform comprises four key modules: image annotation, personal center, forum discussion, and data sharing. The platform's structure is illustrated in Figure 1, providing an overview of its organization and functionality.

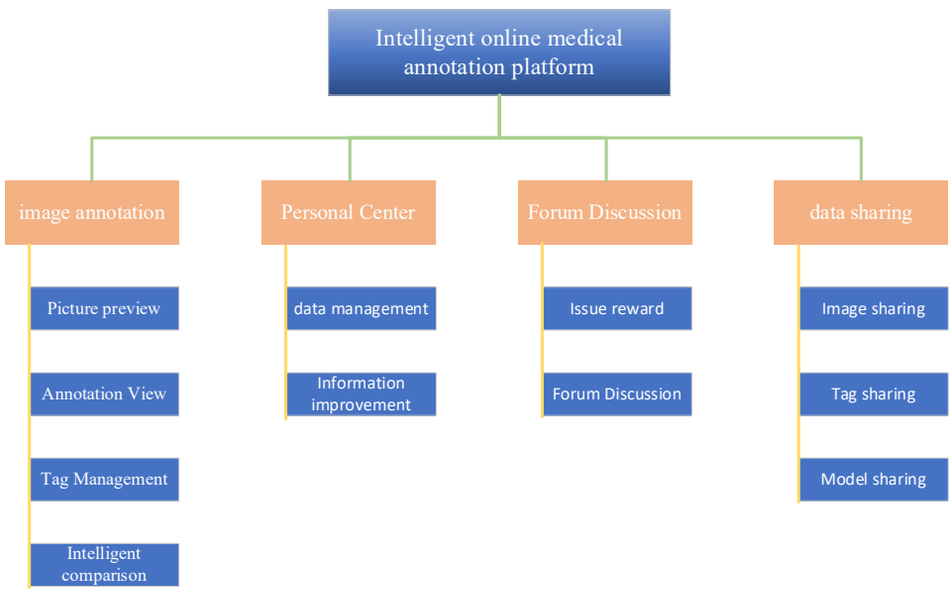


Figure 1: Structure diagram of online medical annotation platform

3.2 Database design

We have developed an entity relationship model tailored to address the specific requirements of users and built a corresponding database accordingly. The visual representation of this model is depicted in Figure 2.

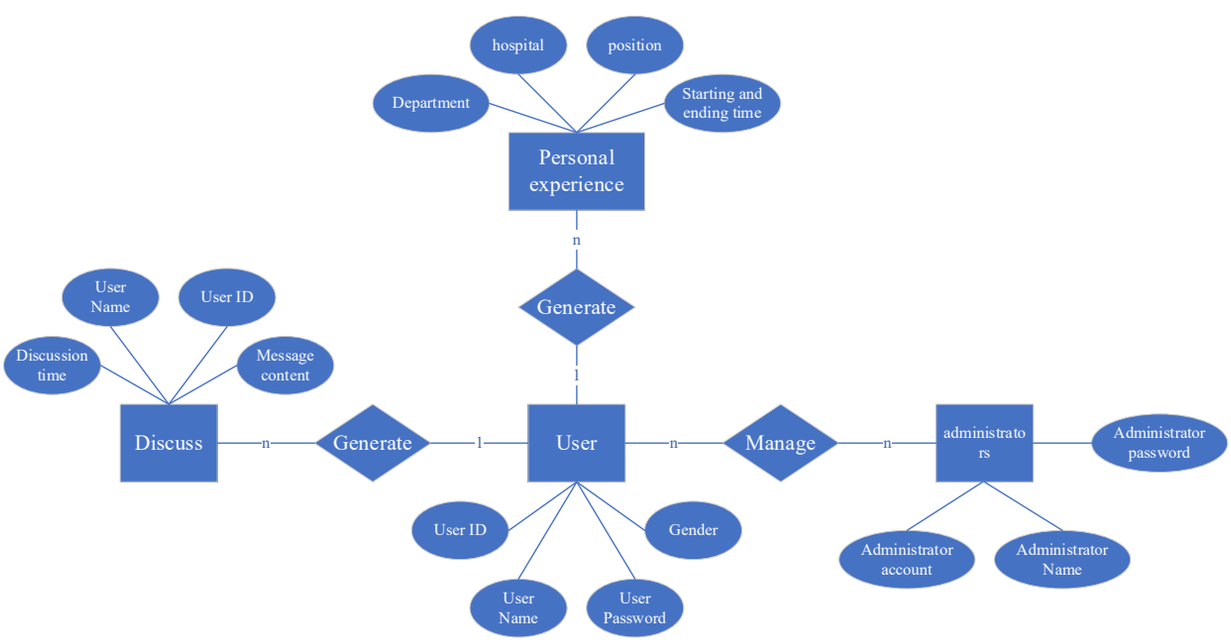
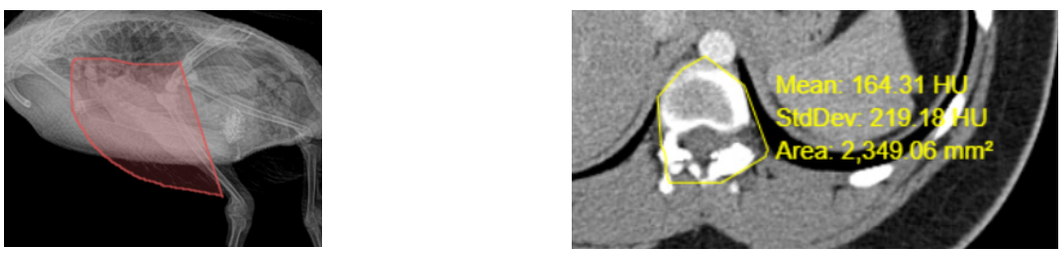


Figure 2: E-R diagram

4. Detail design

4.1 Manual annotation

The manual annotation feature is a fundamental component of our platform, focusing on two primary aspects: file loading and annotation tools. Our platform enables users to locally open and parse various image file formats effortlessly. This includes medical image files like DICOM, as well as common image files such as jpg, png, bmp, and tiff. Moreover, the platform allows annotation of images from network links stored on servers. The practical utilization of some of these tools is depicted in Figure 3, illustrating their effectiveness and user experience.



(a) Fan-shaped tool (b) Line tool

Figure 3: Use effect of some tools

The platform offers a comprehensive range of 32 annotation tools designed to cater to various needs. These tools empower users to perform tasks like text identification, area measurement, length measurement, and angle measurement on images. By utilizing these tools, users can effectively determine the location, size, and shape of lesion areas, aiding doctors in understanding the primary condition of patients and formulating more precise treatment plans.

To enhance the observation of medical images, the platform allows doctors to adjust the window width and window level settings, enabling them to achieve optimal observation outcomes. This feature enables doctors to tailor the visualization parameters to their specific requirements, resulting in improved clarity and ease of analysis. Figure 4 showcases the manual annotation effects on skin cancer images, exemplifying the capabilities and impact of the platform in this domain.

Figure 4: Manual labeling of skin cancer images

4.2 Automatic dimension

The AI intelligent annotation module is a powerful feature that offers users the capability of automatic annotation. Leveraging the potential of big data and advanced algorithms, this module processes DICOM images and applies automatic annotations, thereby liberating users from repetitive manual tasks and allowing them to focus on more meaningful activities.

The operational workflow involves transmitting the user's image to the server for algorithmic analysis. The server then performs the necessary processing and analysis to identify and select the desired area. Finally, the annotated image is returned to the user, providing them with valuable insights and saving their time and effort. This AI-powered module not only enhances efficiency but also enables users to leverage the advantages of machine learning for precise and efficient annotation tasks.

The operation flow on the platform, as described, comprises the following steps:

① In the upper left corner of the image annotation system, locate and click the "Start" button.

② From the drop-down menu that appears, choose either "Open Normal Image File" or "Open Normal Image Folder," depending on your needs.

③ Select the desired image from your local storage by browsing through the file explorer.

④ After loading the image, click on the "Start Mode" button.

⑤ From the drop-down menu that appears, select "Image Segmentation."

⑥ Click on the "Annotation Mode" button.

⑦ From the drop-down menu, choose "Intelligent Annotation" to activate the AI-powered annotation feature.

The interface reflecting this operation flow can be observed in Figure 5, providing users with a visual representation of the process.Following these steps enables users to leverage the intelligent annotation capabilities of the platform, streamlining the annotation process and benefiting from automated analysis and annotations for their images.

Figure 5: Operation interface

Start mode button: This button allows users to select the annotation mode they want to work with. The available annotation modes include object detection and image segmentation. Different annotation modes offer distinct annotation tools and saving methods tailored to their specific requirements.

Annotation mode button: Once the start mode button is selected, users can further refine their annotation approach by choosing the annotation mode. The available annotation modes include manual annotation and intelligent annotation. When intelligent annotation is chosen, the system uploads the user-uploaded image to the server for processing. The server utilizes AI algorithms to perform intelligent segmentation on the image and returns a processed image with AI-generated annotations.

AI intelligent segmentation: This feature involves the development of a deep convolutional neural network model trained on a substantial dataset. This model is deployed on the server. When users opt for intelligent annotation mode, the server receives the uploaded images, processes them using the trained model, performs segmentation, and subsequently returns the annotated image to the user interface.

Figure 6 showcases a comparison of the effects after the automatic annotation process is completed. This visual representation highlights the transformative impact of AI-powered annotations on the images, emphasizing the added value and efficiency brought by the intelligent segmentation feature.

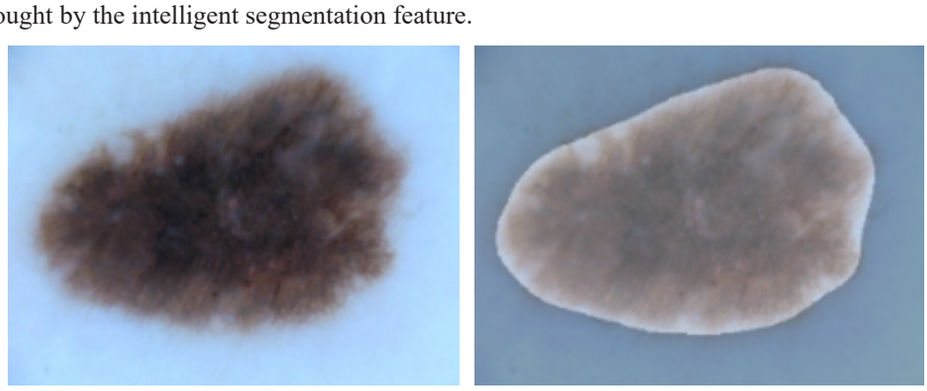


Figure 6: Automatic annotation display

The data was sourced from the publicly available dataset "Skin Cancer MNIST: HAM10000" from Kaggle, which was selected for training. After training, the model achieved a stable accuracy of 97%. Through discussions with experts from the hospital, the use of this AI system has gained some recognition. However, due to the machine's inherent lack of accountability, this method can only serve as an auxiliary tool to assist doctors in diagnosis and reduce their diagnostic pressure. Even if the accuracy reaches perfection, it can only be utilized as a supplementary aid.

4.3 Case records

Electronic medical records (EMRs) have become integral to contemporary healthcare systems. We are incorporating this functionality by integrating it as a component of the document attachment, which will eventually contribute to the comprehensive electronic medical record for each patient. Therefore, the current design output may seem somewhat raw, as the focus is primarily on capturing and documenting the data rather than refining the presentation format. The final outcome will be presented in the form of a Word document, constituting just a portion of the complete medical record. Figure 7 provides a visual representation of the case record being recorded in the system.

After completing this step, the completed case records will be integrated into the patient's individual file. The integrated case records are linked and associated with the existing patient information within the EMR, including previous medical encounters, medication records, allergies, and chronic conditions. This linkage enables a comprehensive view of the patient's healthcare journey over time, promoting continuity of care and informed decision-making. Integrating case records into a comprehensive EMR allows healthcare providers to utilize data analytics and decision support tools. These tools assist in identifying patterns, trends, and insights from large datasets, supporting evidence-based medicine, proactive care management, and research efforts.

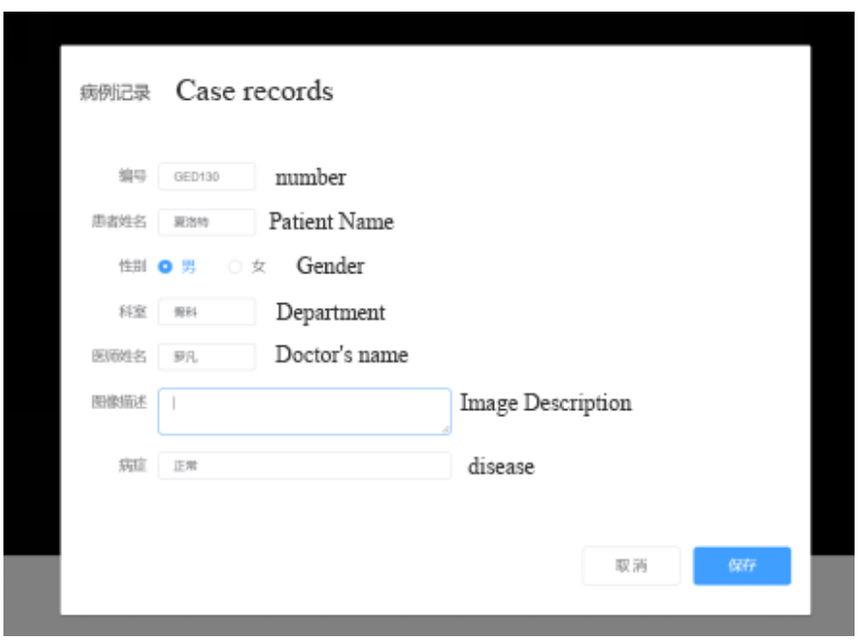


Figure 7: Case record

4.4 Personal Center

Personal profile: Encompasses personal photographs, a personal bio, and a navigation section on the right side (allowing for easy navigation to other parts of the page). To edit the personal profile, simply click the "Edit" button located above it.

Basic information: Presents essential details such as the individual's name, age, gender, hospital affiliation, department, years of medical experience, address, phone number, and email address. To modify the basic information, click the "Edit" button located above it. It is connected to the database, enabling direct modifications.

Employment experience: This section records employment history in the form of charts. It primarily includes details such as the duration, hospital, department, and professional title of previous work experiences.

Medical certification: The medical certification serves as an acknowledgment of a doctor's expertise and is primarily intended for use by medical professionals.

Accompanying notes are often utilized to further explain the certification level.For a more visual representation, please refer to Figure 8, which provides a detailed overview of the specific elements mentioned above.

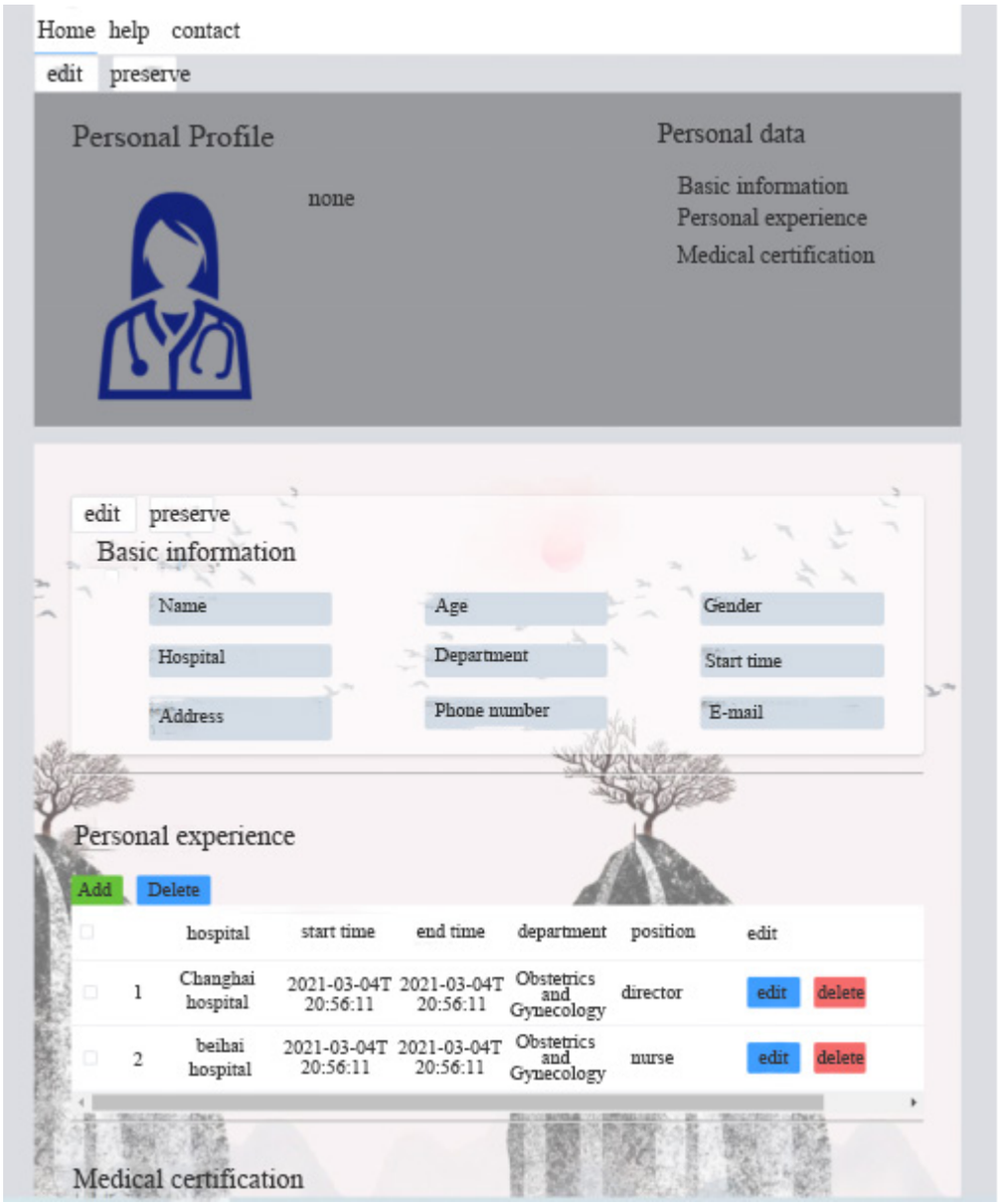


Figure 8: Profile card

5. Conclusions

What we ultimately hope to achieve is a platform for doctors to annotate and interpret medical cases collaboratively. The "Suizhu" platform aims to leverage the advancements in computer technology, including image processing and data analysis, to provide doctors with convenient tools for diagnosing and treating patients.

With the increasing number of patients and limited medical resources, intelligent medicine has become crucial in supporting doctors' decision-making processes. The platform recognizes that the symptoms exhibited by different patients can vary significantly, making accurate disease diagnosis a critical aspect of effective treatment. By harnessing internet technology and computer-based assistance, we aim to provide doctors with the necessary tools and resources to enhance their diagnostic capabilities.

Additionally, the platform acknowledges the potential of utilizing the vast amount of patient health data that can be collected over time. By analyzing and observing this data, it may be possible to identify patterns and trends that could help predict the development of concurrent diseases in the future. This knowledge can aid in strengthening disease control and prevention strategies.

As the platform evolved, we expanded its scope beyond image processing for diagnosis. We recognized that by

transforming doctors who utilize the platform into a collective resource, we can foster stronger connections among medical professionals. This enables doctors to seek assistance from others, particularly in cases where diagnosis becomes challenging due to limited medical resources in certain regions.

In summary, the "Suizhu" platform aims to become a collaborative space where doctors can annotate and interpret medical cases with the assistance of intelligent technology. By leveraging the power of computer technology and connecting doctors through a network platform, we strive to enhance the effectiveness of medical diagnosis and treatment, particularly in regions with uneven medical resources.

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