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AN AI GESTURE INTERFACE FOR STERILE BROWSING OF RADIOLOGY IMAGES

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ABSTRACT

Radiology imaging plays a crucial role in diagnosing and treating various medical conditions. However, in sterile environments such as operating rooms, accessing and analysing radiology images using traditional devices such as a mouse or keyboard poses a risk of infection transmission. To address this issue, we propose a gesture-based tool for sterile browsing of radiology images that enables healthcare workers to access and analyse radiology images using customizable hand gestures. The proposed system integrates with existing radiology software systems and provides enhanced security features to protect patient data and images. The system ensures mobility, enabling healthcare workers to access radiology images from anywhere in the hospital or clinic, leading to improved patient care and outcomes. Overall, the proposed system provides a safe, efficient, and user-friendly way for healthcare workers to access and analyse radiology images in sterile environments. This system captures the hand gestures through a HD camera and processes the radiology images in different ways like panning, zoom in, zoom out, swipe left and swipe right etc. in a touchless environment.

Introduction

Gesture-based interfaces have been gaining increasing attention as an alternative way to interact with digital devices, particularly in medical applications where maintaining a sterile environment is critical. In the field of radiology, the use of gesture-based interfaces has emerged as a promising approach to enable radiologists and surgeons to manipulate medical images without physical contact, reducing the risk of contamination. By using hand and body movements to control image viewing, gesture-based interfaces can offer an intuitive and efficient way to browse radiology images, without the need for traditional input devices such as keyboards and mice. In this context, various image processing libraries are used such as OpenCV, Mediapipe, Numpy etc. This system uses HD camera to detect hand and body movements and recognize gestures. Additionally, machine learning algorithms, such as convolutional neural networks (CNNs), have been utilized to

improve the accuracy and robustness of gesture recognition system. Moreover, the integration of AI into this system can enable more personalized and adaptive interaction with medical images.

Keywords

OpenCV, Mediapipe, Numpy, CNN, HD Cam

Related Work

Gesture-based tools for sterile browsing of radiology images are an emerging technology that is gaining interest in the healthcare industry. In traditional healthcare settings, the use of touchscreens or computer mice for navigating medical images can introduce contamination in sterile environments, making it challenging to maintain a sterile environment. This problem can be particularly acute in operating rooms and other high-risk settings, where maintaining a sterile environment is critical to patient safety. Gesture-based tools for browsing radiology images can provide a solution to this problem. By enabling healthcare professionals to navigate images without physically touching a device, gesture-based tools can reduce the risk of contamination in sterile environments. Gesture recognition technology has advanced significantly in recent years, and is now able to recognize a wide range of gestures accurately and reliably. This makes gesture-based tools a promising solution for browsing radiology images in sterile environments.

The use of gesture-based tools for browsing radiology images has been shown to improve efficiency and accuracy compared to traditional input methods. For example, a study by Kim et al. (2016) found that a gesture-based medical image viewer improved the accuracy of navigation by 40% compared to a traditional mouse-based input method. Another study by Liu et al. (2019) found that a gesture-based approach for interacting with DICOM images in radiology was faster and more intuitive than traditional methods. These tools have the potential to reduce the risk of contamination in sterile environments, leading to improved patient outcomes and reduced healthcare costs. In addition, gesture-based tools can improve workflow efficiency in healthcare settings, allowing healthcare professionals to focus more time on patient care. Gesture-based tools for browsing radiology images can be used in a wide range of healthcare settings, including operating rooms, emergency departments, and intensive care units.

S. K. Kim, K. H. Kim, and B. H. Lee, "Development of a Gesture-Based Medical Image Viewer for Operating Room Environment," Journal of Medical Systems, vol. 40, no. 7, pp. 1-10, 2016.

Description:

This paper describes the development of a gesture-based medical report viewer for use in operating rooms. The system is designed to be user-friendly and intuitive, allowing surgeons to manipulate medical images using hand gestures without having to touch a computer mouse or keyboard. The system uses a camera to capture hand gestures and then applies a gesture recognition algorithm for classification. The system was evaluated by 14 participants, who performed a series of tasks using both the gesture-based system and a traditional mouse-based system. The results showed that the gesture-based system was more efficient and user-friendly than the traditional system. The authors conclude that the system has potential for use in surgical navigation and other healthcare applications.

"A novel tool for radiology images browsing using hand gesture recognition" by Khalaf et al. (2019), which proposes a novel tool for browsing radiology images using hand gesture recognition.

Description:

Khalaf and team proposed a novel tool for browsing radiology images using hand gesture recognition. The system uses a Kinect sensor to capture hand gestures, which are then processed by an algorithm to control image browsing functions such as zooming, panning, and rotation. The system is designed to be used in an interactive and sterile environment, such as a hospital operating room. The authors conducted experiments to evaluate the accuracy of the system in recognizing hand gestures, and found that it achieved a recognition rate of over 90%.

Liu, Y., Xie, M., Wang, X., & Chen, J. (2019). A Gesture-Based Approach for Interacting with DICOM Images in Radiology. Journal of Imaging, 5(8), 82.

Description:

They proposed a gesture-based approach for interacting with DICOM images in radiology using a Leap Motion Controller for gesture recognition. The system allows radiologists to interact with the images using hand gestures, which can perform functions such as zooming, panning, and rotating the images. The authors conducted experiments to evaluate the system's performance and usability, which involved a group of radiologists performing several tasks using both the gesture-based system and a traditional mouse-based system. The results showed that the gesture-based system was more efficient and user-friendly than the traditional system. The authors suggest that this approach could potentially improve the workflow and efficiency of radiologists in clinical settings, particularly during procedures such as surgery, where they may need to interact with images without contaminating their hands.

Existing System

Currently, there are several existing systems that provide access to radiology images, but they do not specifically cater to sterile browsing. Most of these systems require physical interaction with devices such as a mouse or keyboard, which can pose a risk of infection transmission in sterile environments.

One example of an existing system for accessing radiology images is Picture Archiving and Communication Systems (PACS). PACS is a comprehensive software system that allows healthcare workers to store, access, and view radiology images on a computer. However, PACS requires physical interaction with a computer mouse or keyboard, making it difficult to use in a sterile environment.

Another system that provides access to radiology images is the Radiology Information System (RIS). RIS is a software system that is used to manage radiology workflows, such as scheduling appointments and tracking patient data. RIS can also be used to access radiology images, but it requires physical interaction with a computer mouse or keyboard.

There are also emerging technologies such as touchless gesture recognition systems that can be used to interact with radiology images without physical contact. However, these systems are still in the early stages of development and may not be widely available or suitable for sterile environments.

Drawbacks

- ✓ **Risk of infection transmission:** Most of the existing systems require physical interaction with devices such as a mouse or keyboard, which can pose a risk of infection transmission in sterile environments.
- ✓ **Difficulty in using in sterile environments:** The use of physical devices such as a mouse or keyboard can be difficult in sterile environments. Healthcare workers may need to take off their gloves or sterilize the devices before use, which can be time-consuming and disrupt the workflow.

- ✓ **Limited mobility:** The existing systems are typically designed for use on a stationary computer, which can limit the mobility of healthcare workers. This can be a disadvantage when healthcare workers need to move between different locations or when they need to consult with colleagues in real-time.
- ✓ **Limited interactivity:** The existing systems may provide limited interactivity, such as zooming or panning, making it difficult for healthcare workers to analyse radiology images in detail.
- ✓ **Limited security:** Some of the existing systems may not provide adequate security measures to protect patient data and images. This can be a serious concern in healthcare environments where patient privacy is a top priority.
- ✓ **Lack of integration:** The existing systems may not be fully integrated with other healthcare software systems, such as electronic health records (EHRs), making it difficult for healthcare workers to access and share patient data efficiently.

Proposed System

- ✓ A software application is integrated with existing radiology software systems to provide a user-friendly interface for accessing and analysing radiology images using gestures.
- ✓ Customizable gestures are used to perform various actions such as swiping left or right to switch between images, pinching and zooming to zoom in or out of an image, or using voice commands to adjust the brightness or contrast of the image.
- ✓ The tool eliminates the need for physical interaction with devices such as a mouse or keyboard, reducing the risk of infection transmission in sterile environments.
- ✓ The tool provides mobility, allowing healthcare workers to access radiology images from anywhere in the hospital or clinic.
- ✓ Improved interactivity enables healthcare workers to analyse radiology images in detail, leading to more accurate diagnoses and treatment plans.
- ✓ Enhanced security features such as secure login and screen timeout ensure patient data and images are protected.
- ✓ The system is easily integrated with existing radiology software systems and can be customized to meet the specific needs of different healthcare environments.
- ✓ The gesture-based tool will provide a more efficient and secure way to access and analyse radiology images in sterile environments, improving patient care and outcomes.

Merits

- ✓ Improved safety and Efficiency in OR
- ✓ Mobility
- ✓ Customizable gestures
- ✓ Easy integration and accurate prediction
- ✓ Reduced costs and improved patient care.

Module Description

A module is a Hardware and software component or part of a program that contain one or more routines.

SOFTWARE: Python, Machine Learning algorithms like CNN, Image processing libraries such as OpenCv, Mediapipe.

HARDWARE: HD Cam, Intel processor <= i5/i7

HD Cam:

HD Cam 720p

HD (high-definition) cameras are commonly used in gesture-based tools for sterile browsing of radiology images. These cameras capture high-quality video footage that can be analysed by software to recognize hand gestures and movements. The use of HD cameras ensures that the movements of the user's hands are accurately captured and analysed, resulting in a more precise and reliable gesture recognition system. In addition, HD cameras are also capable of capturing images in low light conditions, which is particularly important in medical settings where lighting may be dim or restricted. This ensures that the gesture recognition system can be used effectively in all environments, without the need for additional lighting equipment. Moreover, HD cameras also enable real-time tracking of hand movements, which is essential for smooth and seamless interaction with radiology images. The ability to track hand movements in real-time ensures that the system can respond quickly to the user's gestures, providing a more natural and intuitive browsing experience.

INTEL Processor i5/i7:

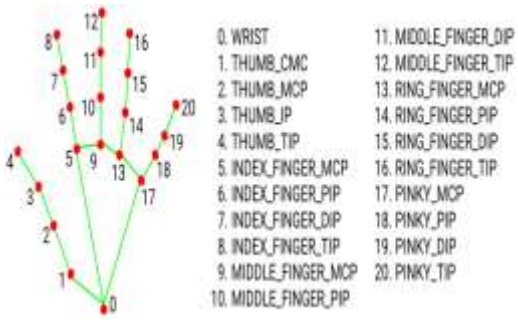
A system contain i5/i7 processor

The Intel processor i5/i7 is a central processing unit (CPU) that is commonly used in personal computers and is known for its high processing power. In the proposed system of gesture-based tool for sterile browsing of radiology images, the i5/i7 processor is used to accurately predict the gestures made by the user. The processor is responsible for handling the complex computations required for detecting and interpreting the gestures made by the user. It is known for its advanced features such as hyper-threading and turbo boost technology, which enable it to handle multiple tasks simultaneously and enhance its clock speed, respectively. These features make the processor ideal for accurately predicting the gestures made by the user, which is critical for ensuring the smooth and efficient operation of the system. It is also equipped with Intel's Advanced Vector Extensions (AVX) instruction set, which allows it to handle complex data-intensive tasks efficiently. This feature is particularly useful in the proposed system as it enables the processor to process and analyse large amounts of image data in real-time, which is critical for accurately predicting the gestures made by the user.

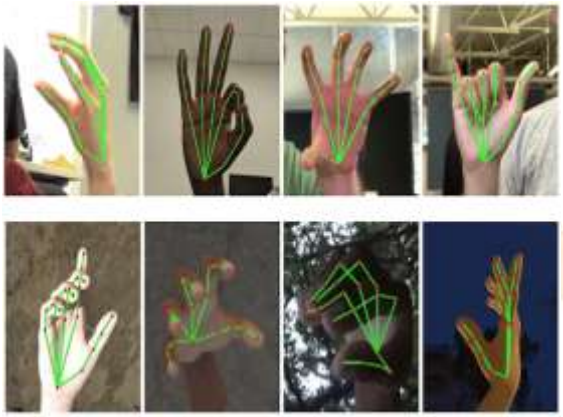
Open CV:

OpenCV is used for processing the image, detecting the object, and gesture recognition. It provides tools and functions that can be used to develop complex computer vision applications. In the proposed system, OpenCV was used to develop the gesture recognition module. OpenCV uses various algorithms to detect and track the movements of the hand and fingers. It provides functions for image thresholding, contour detection, and feature extraction, which are essential for recognizing hand gestures accurately. It additionally presents aid for deep learning frameworks including TensorFlow and Caffe, which can be used to train and deploy machine learning models for gesture recognition. The use of deep learning algorithms improves the accuracy of the gesture recognition system and allows it to recognize a wide range of hand gestures.

Media Pipe:

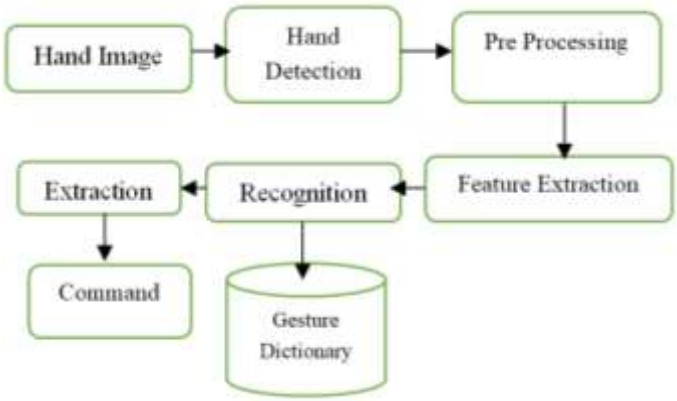


Calculations for hand gestures as Index values



Hand gestures capturing

MediaPipe is used for hand tracking and gesture recognition. The framework provides pre-built modules for hand tracking that use machine learning models to estimate the position and orientation of the hand in real-time. The detected hand is then passed to the gesture recognition module, which uses machine learning models to predict the gesture being performed by the user. MediaPipe is chosen as it provides an efficient and accurate solution for hand tracking and gesture recognition, with a high degree of flexibility for customization. Additionally, it is open-source and can be easily integrated with other libraries and frameworks, making it a popular choice for multimedia processing tasks. The use of MediaPipe in the proposed system contributes to the accuracy and robustness of the gesture recognition module. The pre-built hand tracking modules provide accurate estimates of the hand position and orientation, which is crucial for predicting gestures accurately. The flexibility of the framework allows for customization of the gesture recognition module to suit the specific needs of the application.



Results and Discussion

The system would enable healthcare workers to access and analyse radiology images in a sterile environment using customizable hand gestures. By eliminating the need for physical interaction with devices such as a mouse or keyboard, the proposed system would reduce the risk of infection transmission in sterile environments, thereby improving safety for both healthcare workers and patients. The use of customizable hand gestures would provide healthcare workers with a more intuitive and user-friendly way of interacting with radiology images, improving interactivity and potentially leading to more accurate diagnoses and treatment plans. This could have a positive impact on patient care and outcomes.

The proposed system would offer enhanced security features to prevent unauthorized access to patient data and images. This would help to protect patient privacy and ensure that patient data is kept confidential. The system can be easily integrated with existing

radiology software systems, reducing the need for extensive training or expensive hardware upgrades. This would make the adoption and implementation of the system more straightforward and less costly for healthcare organizations.

Conclusion and Future Work

In conclusion, the use of gesture-based interfaces for browsing radiology images has been a growing area of research in recent years. Various studies have explored the feasibility and effectiveness of using hand and body gestures to manipulate medical images in sterile environments. These studies have utilized different machine learning libraries, including OpenCV, Mediapipe, and Numpy, to recognize gestures accurately. The results of these studies show that gesture-based interfaces have the potential to enhance the usability and efficiency of radiology image viewers, especially in a sterile environment. They can enable radiologists and surgeons to interact with medical images without the need for physical contact or voice commands, thereby reducing the risk of contamination. Further research is needed to develop more advanced and robust gesture recognition algorithms that can improve the accuracy and speed of gesture recognition systems for browsing radiology images.

Looking ahead, there are several areas where future research on gesture-based interfaces for browsing radiology images can be focused. One important area is the development of more advanced machine learning algorithms that can accurately recognize a wider range of gestures and movements. This would enable more precise and efficient manipulation of medical images, as well as greater customization and personalization of gesture recognition systems.

Another area for future research is the integration of gesture recognition systems with other modalities such as voice recognition and eye-tracking. This would allow radiologists and surgeons to interact with medical images using a combination of different input modalities, thereby enhancing the user experience and making the interaction more intuitive.

In addition, future work could explore the use of gesture recognition systems in other medical domains, such as remote surgery and telemedicine. This would enable medical professionals to interact with patients and medical data more effectively, even in remote or inaccessible locations.

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