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Plagiarism Scan Report

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Abstract: Background and Objective: The complexity of laparoscopy requires specialized training and evaluation. Analyzing streamed videos during surgical procedures may enhance surgical training. Fatigue and costs associated with such analysis can be significantly reduced using an automated detection system, thereby reducing potential medical errors. Identification of surgical instruments is a fundamental task for analyzing and evaluating surgical videos. However, the focus has mainly been on minimally invasive surgery (MIS) and cataract surgery. Therefore, identifying surgical instruments can be a crucial and supportive step in reducing evaluation errors, training human resources, as well as analyzing and summarizing the surgical process. Various tools, including deep learning for surgical instrument detection, can be employed, but appropriate image preprocessing is necessary to improve the results. The aim of this paper is to present a method to enhance the results of deep learning models based on CNN and LSTM by preprocessing and edge detection of input images. Method: Our proposed method consists of three steps. In the first step, images are preprocessed using edge detection filters like Sharp, Sobel, Canny, Roberts, and Prewitt. Then, a hierarchical CNN and LSTM-based method is used to extract suitable features from the image and perform classification. A CNN model was used to learn spatial features from laparoscopic images. An LSTM network named LSTM-clip was utilized to learn temporal dependencies from intermediate video clips, and then temporal dependencies in full surgical videos were modeled using another LSTM named LSTM-video. Results: The proposed method was implemented on the large publicly available Cholec80 dataset. Results were evaluated based on Precision, Recall, Accuracy, and AUC metrics. Two types of experiments were conducted in this research; in the first experiment, the presence or absence of surgical instruments in the image was examined. Based on this experiment and the results obtained, the deep learning model using the Prewitt filter showed better performance. In the second experiment, the detection of surgical instrument types was investigated. In this experiment, the deep learning model using the Sharp filter outperformed other filters. Key Words: Surgical instrument detection, edge detection, deep learning, image preprocessing 1.Introduction Machine vision and image processing have widespread applications in various fields and industries today. The goal of machine vision is to analyze and extract information from images for better understanding.

Different processing tools are used in this field depending on the type of information that needs to be extracted from the image. The advancement of machine learning algorithms such as deep learning in recent years has led to increased attention to machine vision. One of the areas where machine learning, especially machine vision, is highly applicable today is in the field of medicine. Applications such as cancer diagnosis using medical images [1], detection of medical instruments [2], estimating age from dental images [3], and more are examples of machine vision applications in medicine and healthcare. The detection of surgical instruments from a self-centric perspective in the operating room is a fundamental task for the development of intelligent systems that can assist surgeons in real-time. For example, detecting a tool can inform surgeons and prevent incidents such as leaving gauze inside the body. Recently, various approaches for detecting surgical instruments, especially in minimally invasive surgeries (MIS), have been proposed [4,5]. The numerous advantages of minimally invasive surgery, such as shorter recovery time, less pain and blood loss, and better cosmetic outcomes, have made it a preferred choice over traditional open surgeries [6]. In laparoscopy, surgical instruments are inserted through small incisions in the abdominal wall and monitored using a laparoscope. The specific manipulation of surgical instruments and indirect observation of the surgical scene pose additional challenges in performing laparoscopic procedures [7]. The complexity of laparoscopy requires specialized training and evaluation for surgical assistants to acquire the necessary skills. For such training and evaluation, videos of previous procedures performed by experienced surgeons can be utilized. Fatigue and the cost of training and evaluation can be significantly reduced, among other things, by using an automated tool detection system. In robotic-assisted interventions, surgical instruments are controlled by a robot specifically designed to assist a surgeon who needs real-time understanding of the current task. This robot aids the surgeon in controlling surgical instruments and provides real-time task awareness. In this approach, identifying the presence, position, and placement of surgical instruments in robotic surgeries can also be beneficial. On the other hand, the actual location and movement of the instruments can significantly contribute to the evaluation of surgeries and the generation of useful operation summaries [8, 9]. In the future, operating rooms will utilize machine assistance for knowledge-based analysis of available data to enable new decision support systems or context-aware systems (CAS). The goal of CAS is to optimize surgical treatment by analyzing and correlating data from various medical fields, improving surgical performance, and providing relevant information to human operators during surgical interventions. Analyzing the use of surgical instruments is a fundamental objective in CAS as it enables the recognition of surgical phases. Additionally, automatic detection of surgical instruments may be utilized for automated reporting during the surgical process [10, 11, 12]. Various methods have been proposed for the detection of surgical instruments, with machine learning-based approaches and algorithms related to video analysis having wide applications in this field [13]. Automatic analysis of surgical videos for gathering information about

surgeries has been crucial. By combining machine vision and machine learning, performance can be improved to enhance the safety and efficiency of surgeries. Significant attention to the analysis of surgical videos has sparked active research in the medical machine vision community [14, 15]. Tool detection based on video is a desirable method in minimally invasive surgery, as endoscopic videos provide an easy source for recording information. However, tool detection based on video remains a challenging task. In particular, detecting surgical instruments involves multi-object detection tasks with various combinations of tools. Laparoscopic images may face limitations and challenges due to the rapid movement of the laparoscope camera, smoke, tissue deformations, and blood covering the instruments [16].

Sources