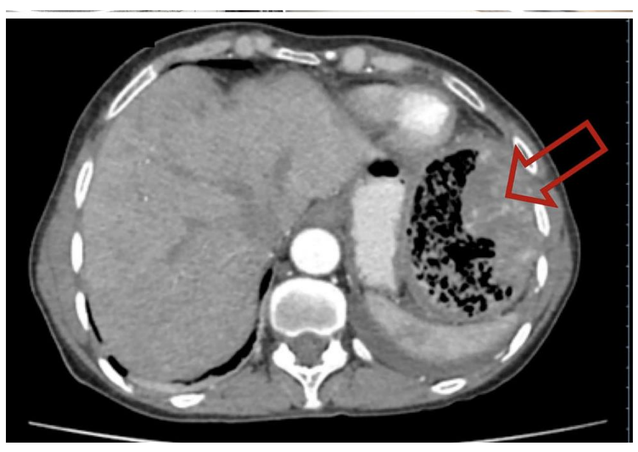
NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

MAE23083– SMART OPERATION THEATRE

Presented by SARAF KRISH

Supervised by Dr Cai Yiyu, Co-supervisor Dr Huang Li Hui, Abu Bakr Azam

Introduction



When performing surgeries, doctors need to use medical gauze to stop bleeding at surgery sites. Sometimes, doctors forget to remove the gauze from the patient's body, so it stays inside and may cause pain, abscess formation or septic shock, which is called Gossypiboma. To prevent gossypiboma, three main methods are currently utilized: manual counting, RFID-enabled gauzes, and X-ray detectable gauzes. Although, RFID and X-ray detectable gauzes can significantly reduce human errors, it costs 40-50 times higher than standard gauzes. Thus, the majority (-97%) of hospitals tend to manually count the gauzes, with errors being inevitable

Clinical Significance

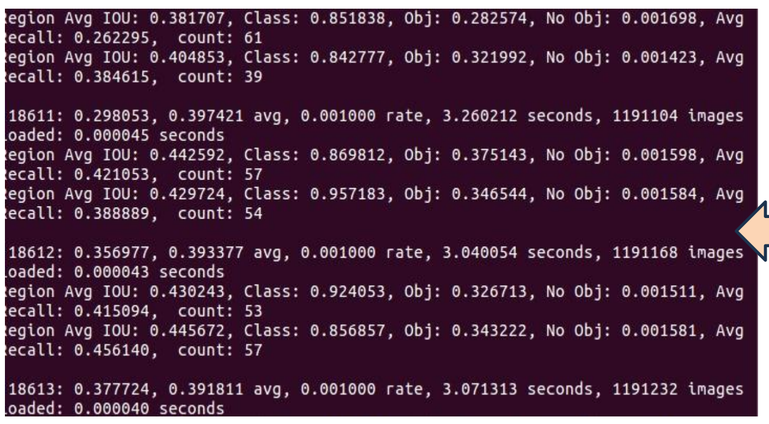
We have established a collaborative partnership with Singapore General Hospital (SGH), whose expertise we will leverage for training and deployment phases. Medical professionals have delineated various scenarios that may arise during surgical procedures. In response, we have documented our image collection within actual operational theaters, ensuring these capture a comprehensive array of situations, including overlapping gauzes, shadows and excessive lighting, to replicate the dynamics of live operations. Currently, we are conducting trials with our finalized model in actual surgeries to identify and address potential limitations, with the aim of refining and enhancing our models performance.

Methodology

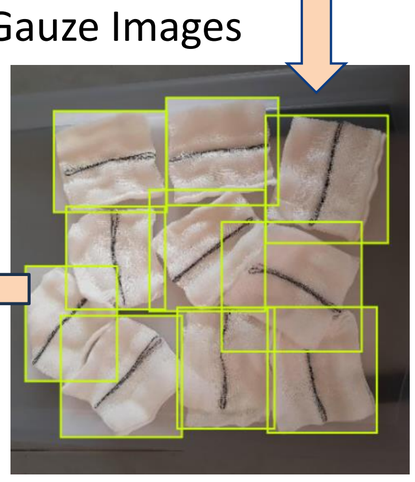
We use a dual-tray system, marked "In" for unused gauzes and "Out" for used ones. We have scraped images from videos capturing gauze manipulation in our dual-try system under various conditions, including lighting and placement changes. The images extracted is then labelled following which this data is augmented to improve object detection and increase the datasets size for increased accuracy. A YOLOv7-based neural network is trained and deployed to identify gauzes and hands. A Python application using this model monitors gauze movement by precise object detection and real-time tracking, displaying ongoing counts for both the trays, respectively.

2 Tray System

Collecting Gauze Images



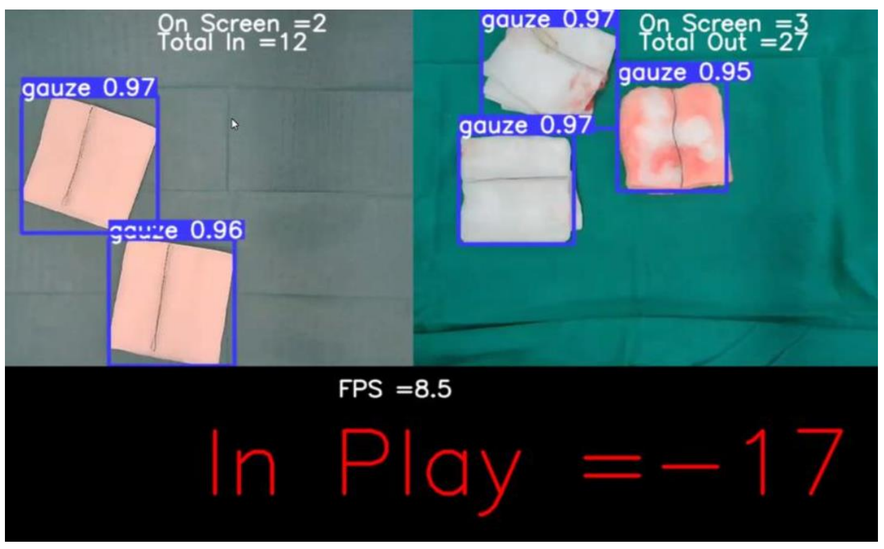
Train Yolov7 Model



Labelling Gauzes

Results

Currently as seen in the figure below, the code runs in real time and has 2 live screens, one each for the "In" and "Out" tray, where our model detects gauzes and hands. "On Screen" tells the number of gauzes currently as seen on the trays while "Total In" represents the total number of gauzes which have already been put in the "In" tray since the beginning of the operation. This is similarly followed for the Out tray and "In Play" represents "Total In - On Screen - Total Out", which represents the number of gauzes which will be inside the patient's body. The aim is that after the operation concludes "Total In" and "Total Out" have the same value while "In Play=0", representing that there are no gauzes left behind in the patient's body.



Discussions and Future Work

While preliminary versions of the system detect gauzes and hands with 2 separate models, we have now created an integrated model capable of detecting both gauzes and hands and also increased our dataset size 8x than before. This has further improved its precision and FPS rate. Currently our design includes connecting a laptop with the cameras and running our python code on it. Our future goal is to modify the 2 Tray system to include a TV Screen which has the model running in the backend on a disc so the external laptop dependency gets over. After testing with another 15-20 hospitals in Singapore to get more feedback and improving our existing product, we wish to go commercial by selling this to hospitals to help achieve more precision in gauze counting and reduce Gossypiboma cases.