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A Study on the AI – Based Robotic Drone for Emergency Medical Applications using Python Programming

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ABSTRACT: Drones can deliver payloads, acquire real-time data in an efficient and cost-effective manner, and have been a driving force behind the rapid development of a wide variety of industrial, commercial, and recreational applications. In order to attend the requirements of living human people in terms of medical services or support, drones play a crucial role. The study met the challenges related to model's weights that iteratively changed depending on the computed loss and gradients with respect to the loss. The optimizer makes adjustments to the weights in order to reduce the amount of loss and improve the model's overall performance on the given task. Regrettably, advancements in medical science have occurred at a more glacial pace in recent years. The primary objective of this research is to carry out a study on the application of AI-based robotic drones to emergency medical situations. This kind of visualisation enables you to keep track of how well your model is picking up new information during training and to see any problems like over- or under fitting. The accuracy rate was found to be 0.8530% and the loss function was found to be 0.4625% based on the research's findings.

Keywords: Artificial Intelligence, Drones, Medical Applications, Robotics.

INTRODUCTION

Today, unmanned systems are used in a wide variety of different applications. Drones, which are short for unmanned aerial vehicles (UAVs), are widely recognised as being among the most potent forms of airborne technology. There are several applications for drone technology that can help a variety of fields. Aerial photography, surveillance, transportation and delivery, military applications, and a wide variety of other tasks can all be accomplished with the assistance of drones (Rosser *et al.*, 2018). Most of drones may be flown in two different modes. The first mode of operation for the drone is one in which it can fly totally independently and without any assistance from a human pilot. Before taking off, it is necessary to link the drone to its on-board computer in order to establish a flight plan and follow it. The second kind of flight involves the pilot being stationed in something resembling an operating room, from which he exercises complete command of the drone. In order to precisely locate their location, drones often require a high-precision GPS system (Batth *et al.*, 2018; Al-Turjman & Zahmatkesh 2020). An artificial intelligence system can have a variety of payloads loaded into it if it has a vast number of scaled detectors, sensors, and cameras, among other types of hardware (Jat & Singh 2020).

Fig. 1. A picture of drone delivery.

Drones have many applications, one of which is to protect package delivery workers from unwarranted assaults. Traditional inspection methods are typically hazardous for the persons involved. The inspection can be carried out independently of any involvement from a human being thanks to the assistance of a drone (Soori *et al.*, 2023). Therefore, the purpose of this research is to develop an AI-based robotic drone that can be programmed in Python and used for emergency medical applications. The previous literatures that pertain to this notion are discussed in greater detail in the next section.

LITERATURE REVIEW

Table 1: Literature Review.

Authors and Year	Methodology	Findings
Damoah *et al.* (2021)	In order to investigate how an AI-enhanced medical drone application in Ghana's healthcare supply chain (HSC) enhances the HSC system and aids in sustainable development, this study used corporate social responsibility (CSR) as a theoretical lens. In-depth semi-structured interviews and a documentary from Ghana's largest medical drone initiative were used to gather the data for this study.	The results show that an AI-enhanced medical drone application in HSC considerably advances the sustainable development goals (SDGs), with a focus on SDGs related to climate change in the host country. The SDGs are accomplished by using drones that are carbon- and noise-free to carry emergency medical supplies to healthcare facilities.
Kotlinski & Calkowska (2022)	Many European projects evaluate UTM capabilities in an effort to establish a solution that will enable the market and guarantee safe UAV operations. One of those systems is Pansa UTM, which was created to organise drone flights in various Polish airspace categories.	The first section of the article demonstrated how this technology can be used for new drone applications and more operations. In pace with the growing expansion of UAS flights and drone service applications, the European drone ecosystem should advance further to deploy more sophisticated drone operations scalable. Europe is ready to deploy Advanced Air Mobility for unmanned air taxis, freight flights, medical cargo flights, autonomous surveillance flights, etc.
Kavya *et al.* (2022)	Drone emergency response services open up new opportunities for life-saving actions, especially in medical situations. Drone use to keep "eyes" on risky situations or to provide medical supplies to patients who are stranded could improve emergency response doctors' ability to treat patients in perilous situations.	Numerous emergency response services are offered through the Internet of Drones (IOD), which has an impact on daily life. The Federal Aviation Administration (FAA) flies over people and on fully autonomous missions to deliver vital medical supplies beyond sight range. The future of the unmanned aerial vehicle in a variety of applications lies on artificial intelligence and machine learning.
Siripurapu *et al.* (2023)	The review focused on the role that emerging technologies, including artificial intelligence, big data, block chains, open-source software, cloud computing, etc., can play in the healthcare industry and its related divisions.	The review focused on the role that emerging technologies, including artificial intelligence, big data, block chains, open-source software, cloud computing, etc., can play in the healthcare industry and its related divisions.
Damaševičius *et al.* (2023)	Numerous emergency response services are offered through the Internet of Drones (IOD), which has an impact on daily life. The Federal Aviation Administration (FAA) flies over people and on fully autonomous missions to deliver vital medical supplies beyond sight range. The future of the unmanned aerial vehicle in a variety of applications lies on artificial intelligence and machine learning.	IoES integration into emergency management has a lot of potential to increase the effectiveness and timeliness of disaster response as well as the general safety and well-being of citizens during emergencies. To ensure its efficient and responsible use, it is crucial to be aware of any potential restrictions and risks related to this technology.

According to previous literature, the drone is a promising technology with great potential for use in emergency medical situations, such as the pandemic age, as well as by keeping an eye on and reducing crowding of people during a lockdown. It is the next degree of surveillance that lessens the hazard of sickness and human energy. This study's primary goal is to investigate the AI-based robotic drone for emergency medical applications.

METHODOLOGY

Python programming platforms are used to implement this study. The main focus of this research is the deep learning-based image segmentation. Three stages are used to carry out the study:

A. Drone Image Segmentation
B. Drone Detection using Pytorch
C. Aerial Semantic Segmentation and Drone Detection

A. Drone Image Segmentation

This study defines the configuration container Python class 'Config'. This class stores script and programme parameters and settings. A deep learning model for picture segmentation uses these parameters to control various tasks. This code creates a configuration class with many deep learning-based photo segmentation options. Model hyperparameters, training settings, and directory paths are among them. This solution simplifies parameter control and adjustment in one place, encouraging modularity and maintainability in the code. The following section imports PyTorch and additional utility libraries and modules. It also adds a Python system path route to "drone-image-segmentation-notebook-demo" where the "mix_transformer" module should be. PyTorch, modules, and neural network features are imported.

The script function set_all_random_seed sets random seeds for various random number generators. It ensures results can be reproduced. The current time is the default seed. The function returns the seed. After that, the seed is printed. This script configures PyTorch, data loading, and other tools. A function check_mit_transformer() that analyses a random image using an MIT-B0 encoder model and produces feature map and image tensor shapes. The code also checks a CFG.debug_level debugging condition before invoking the function. The next stages define MyUpSample and MyDecoder, neural network architecture classes. Segmentation tasks use a 2D-based cross-entropy loss function. It needs logit (the model's output logits) and truth (ground truth labels). After checking input shapes and formats, the function computes a valid mask to exclude certain labels before computing cross-entropy loss using those entries. Make up the lost. This algorithm uses semantic segmentation and drone imagery. It uses pandas, opencv, numpy, and pytorch in Python. This study's stages are listed below:

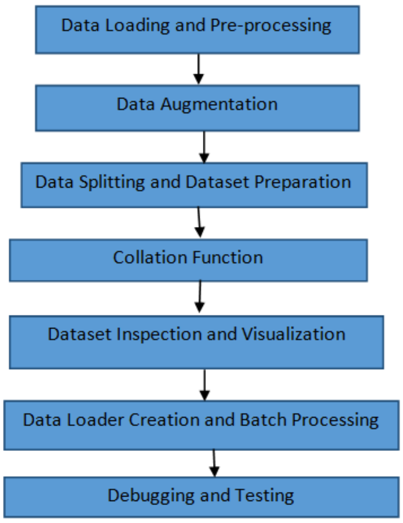

Fig. 2. Flowchart of this study.

The loading and preliminary processing of drone image data for semantic segmentation tasks is the focus of this code section. In addition to visualisation for troubleshooting, it describes the dataset class, augmentation functions, data separation, and Data Loader configuration. It provides many training and logging-related functions and is used to build a neural network for an image processing task. Here is a list of what this study accomplished.

B. Drone Detection using Pytorch

The core environment for computer vision activities, such as data preprocessing, augmentation, model creation, training, and evaluation, was established in this step. Images and their related annotations would be loaded into these variables for use during training in a typical computer vision training pipeline.

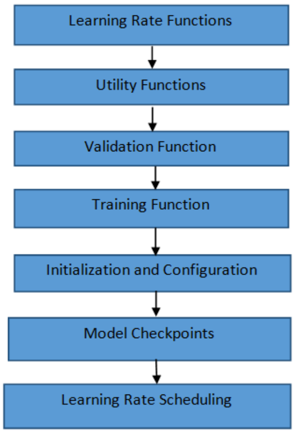

Fig. 3. Flow chart of training of datasets.

Two DataFrames—*train_ds* for the training dataset and *val_ds* for the validation dataset—are produced as a result of this phase. These DataFrames have been divided depending on the number of rows and only include valid bounding box information. The needs of the dataset and the calibre of the original annotations determine the precise numbers utilised for splitting and the elimination of erroneous bounding boxes. For the purpose of training a Faster R-CNN model, this dataset class is meant to be utilised as part of the data loading procedure. It handles picture loading, annotation extraction, image pre-processing, and data conversion into a format appropriate for model training. The class makes it simpler to include unique datasets into the PyTorch framework.

This study loads a Faster R-CNN model that has been pre-trained on object detection using the COCO dataset from the torchvision library. A well-liked object detection architecture called Faster R-CNN combines deep neural networks with region proposal networks (RPN) to find things in images. The model has already been trained on the COCO dataset, which is a sizable benchmark for object detection tasks, and with the aid of the ResNet-50 backbone and FPN modules, learns hierarchical features from photos. Using the pre-trained Faster R-CNN model's obj_detector function and to visualise the object identification results for a series of images Bounding boxes and labels for the detected objects are included in the visualisation.

C. Aerial Semantic Segmentation and Drone Detection

Importing different Python libraries for data processing, visualisation, and deep learning with TensorFlow is done in this study. Its purpose is to set up the working environment for manipulating data, displaying data, and creating neural networks with TensorFlow's Keras API.A predetermined number of image and mask pairs can be displayed side by side using the function plt_image_and_mask_by_path. It reads image and mask files using the imageio library, then displays the pictures using the matplotlib library. Convolutional neural networks, which are frequently employed for tasks like image segmentation, define a building block for down sampled layers using the conv_block function. It can incorporate convolutional layers, dropout layers, and max-pooling layers depending on the parameters supplied to the function, giving network designers flexibility.

The unet_model function builds a U-Net architecture with programmable input size, filtering number, and output class parameters. U-Net is frequently used for picture segmentation tasks because of its effectiveness in capturing context and fine-grained details through its expanding and contracting routes. The outcome is two parallel plots that display the evolution of training accuracy and loss across the designated number of epochs. This kind of visualisation enables you to keep track of how well your model is picking up new information during training and to see any problems like over- or underfitting.

RESULTS AND DISCUSSIONS

Deep learning-based picture segmentation is the major method employed in this study. Neural networks are used in deep learning to directly learn usable representations of features from input. A pretrained neural network, for instance, can be used to recognise and eliminate picture artefacts like noise. Convolutional Networks for Biomedical Image Segmentation introduces U-Net, an encoder (for downsampling) and a decoder (for upsampling) with skip connections make up the model's very straightforward architecture. Its shape is similar to the letter U, as shown in Figure below, therefore the name U-Net.

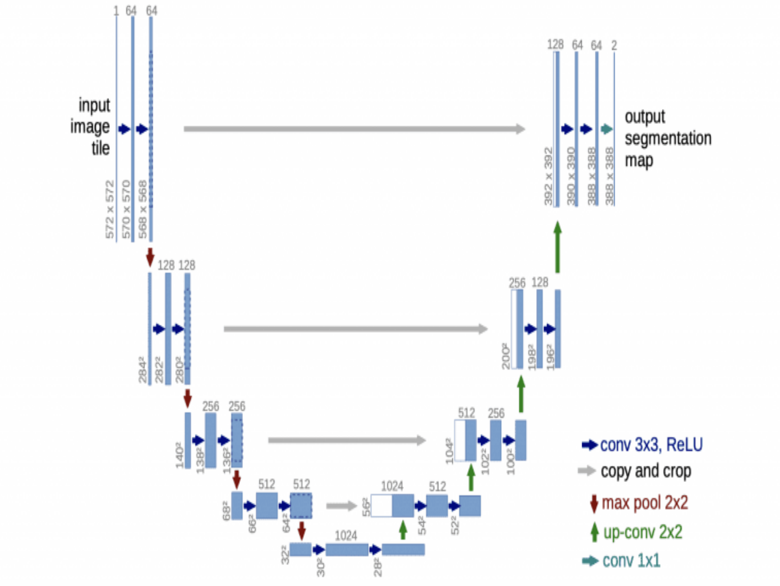

Fig. 4. U-Net Architecture.

The training accuracy can be illustrated by using following diagram.

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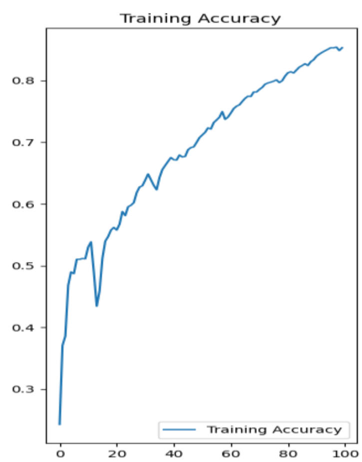

Fig. 5. Training Accuracy graph.

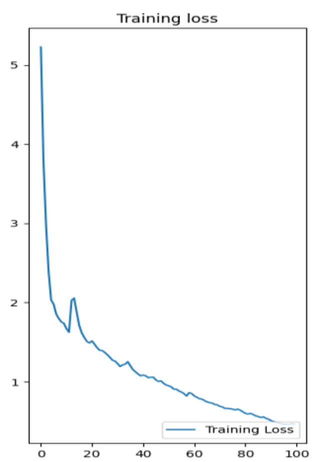

Fig. 6. Training Loss.

The end product is a pair of plots that are laid out next to one another and indicate how the level of training accuracy and loss changed over the course of the allotted number of epochs. With the assistance of this type of visualisation, which also enables you to spot any faults, such as overfitting or under fitting, it is possible to monitor how effectively your model is learning while it is going through the training process.

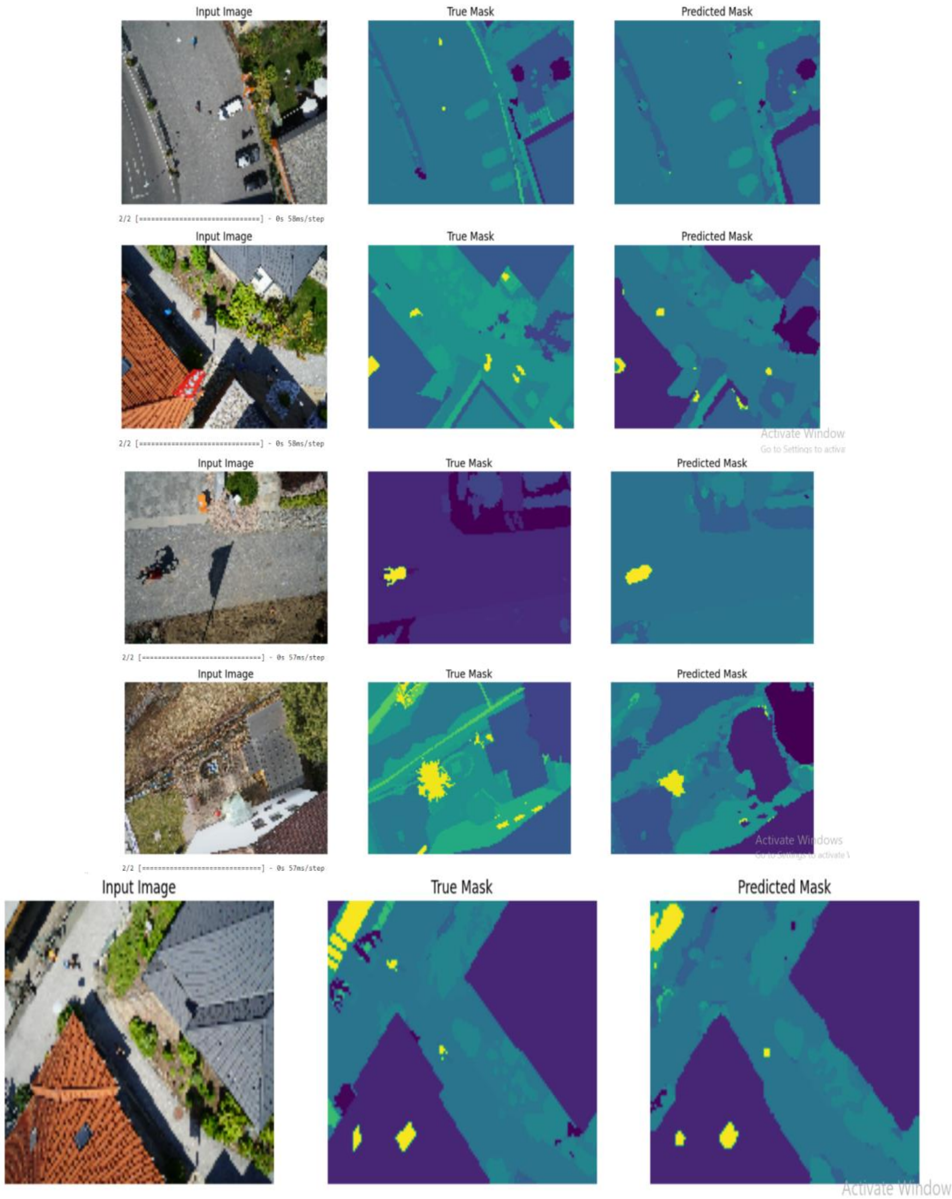

Fig. 7. Final output showing input, true mask and predicted mask images.

CONCLUSION

A U-Net model built with Tensor Flow's Keras application programming interface (API). The configuration of the model's training procedure is accomplished through the usage of the compile function. After the model has been compiled, it is now prepared to be trained with the help of the fit function. During training, the model's weights are iteratively changed depending on the computed loss and gradients with respect to the loss. This process takes place in the background. The optimizer makes adjustments to the weights in order to reduce the amount of loss and improve the model's overall performance on the given task. During training, the metrics that are given in the compile function are calculated and shown. This is done in order to provide insights into the performance of the model as it learns from the training data. According to the findings of this investigation, the accuracy rate was found to be 0.8530%, and the loss function was found to be 0.4625%.

FUTURE SCOPE

Drones can deliver payloads, acquire real-time data in an efficient and cost-effective manner, and have been a driving force behind the rapid development of a wide variety of industrial, commercial, and recreational applications. In order to attend the requirements of living human people in terms of medical services or support, drones play a crucial role. Regrettably, advancements in medical science have occurred at a more glacial pace in recent years. In future, drones can be use to keep "eyes" on risky situations or to provide medical supplies to patients who are stranded could improve emergency response doctors' ability to treat patients in perilous situations.

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Conflict of Interest. There is no conflict of interest among the authors.

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