



LIVER ISOLATION FROM ABDOMEN CT

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ABSTRACT The liver is a vital organ for humans and other vertebrates, it is the only organ which is capable of regeneration. Due to the multi-functional nature of the liver and its location in the body, liver diagnosis is proven to be very important and a hard concept. Early segmentation of liver helps doctors to solve the problems earlier and faster diagnosis and treatment of the disease. We are using a type of CNN called the U-NETS which consist of two halves which helps in easier segmentation of the liver. Using CNN for segmentation purpose helps in increasing the accuracy of the segmentation and makes the model more robust compared to the traditional image processing techniques.

KEYWORDS : CNN-Convolutional Neural Networks , NN-Neural Networks.

1 INTRODUCTION

Liver is one of the organ in human body whose diagnosis is quite difficult due to its placement in the human body and being surrounded by lots of other soft tissue organs the visualization and isolation of liver using various imaging modalities is difficult and labourous task.

Various imaging modalities are :

- **Ultra sound** : Ultrasound is a type of imaging. It uses high-frequency sound waves to look at organs and structures inside the body. Ultrasound imaging of the abdomen uses sound waves to produce pictures of the structures within the upper abdomen. During pregnancy, doctors use ultrasound to view the fetus. Unlike x-rays, ultrasound does not expose you to radiation. It is inexpensive and easily available.
- **MRI (Magnetic Resonance Imaging)** : Magnetic resonance imaging (MRI) is a medical imaging technique used in radiology to form pictures of the anatomy and the physiological processes of the body in both health and disease. MRI scanners use strong magnetic fields, radio waves, and field gradients to generate images of the organs in the body. It provides high lesion to liver contrast and does not use ionizing radiation. It also uses breath hold 3D imaging, high spatial resolution, and Rapid half-Fourier acquisition. The strong, static magnetic field will attract magnetic objects (from small items such as keys and cell phones, to large, heavy items such as oxygen tanks and floor buffers) and may cause damage to the scanner or injury to the patient or medical professionals if those objects become projectiles.
- **PET(Positron Emission Tomography)** : Positron emission tomography (PET) is a nuclear medicine functional imaging technique that is used to observe metabolic processes in the body. The system detects pairs of gamma rays emitted indirectly by a positron-emitting radio-nuclide (tracer), which is introduced into the body on a biologically active molecule. Three-dimensional images of tracer concentration within the body are then constructed by computer analysis. PET is both a medical and research tool. It is used heavily in clinical oncology (medical imaging of tumors and the search for metastases), and for clinical diagnosis of certain diffuse brain diseases such as those causing various types of dementias. PET is also an important research tool to map normal human brain and heart function, and support drug development.
- **CT(Computed tomography)** : We are using computed tomography because it is usually preferred by diagnosticians as they provide accurate anatomical information about visualized structures. It provides Greater sensitivity to distinguish tissue density differences. Computed tomography (CT) is an imaging procedure that uses special x-ray equipment to create detailed pictures, or scans, of areas inside the body. It is also called computerized tomography and computerized axial tomography (CAT). The term tomography comes from the Greek words tomos (a cut, a slice, or a section) and graphein (to write or record). Each picture created during a CT procedure shows the organs, bones, and other tissues in a thin "slice" of the body. The entire series of pictures produced in CT is like a loaf of sliced bread—you can look at each slice individually (2-dimensional pictures), or you can

look at the whole loaf (a 3-dimensional picture). Computer programs are used to create both types of pictures.

1.1 U-NETS

The U-Net is a convolutional neural network that was developed for biomedical image segmentation at the Computer Science Department of the University of Freiburg, Germany. The network is based on the fully convolutional network and its architecture was modified and extended to work with fewer training images and to yield more precise segmentations. Segmentation of a 512*512 image takes less than a second on a recent GPU. The U-Net is a more elegant architecture, the so-called "fully convolutional network". The main idea is to supplement a usual contracting network by successive layers, where pooling operations are replaced by up sampling operators. Hence these layers increase the resolution of the output. What's more, a successive convolutional layer can then learn to assemble a precise output based on this information. One important modification in U-Net is that there are a large number of feature channels in the up sampling part, which allow the network to propagate context information to higher resolution layers. As a consequence, the expansive path is more or less symmetric to the contracting part, and yields a u-shaped architecture. The network only uses the valid part of each convolution without any fully connected layers. To predict the pixels in the border region of the image, the missing context is extrapolated by mirroring the input image. This tiling strategy is important to apply the network to large images, since otherwise the resolution would be limited by the GPU memory.

Network Architecture

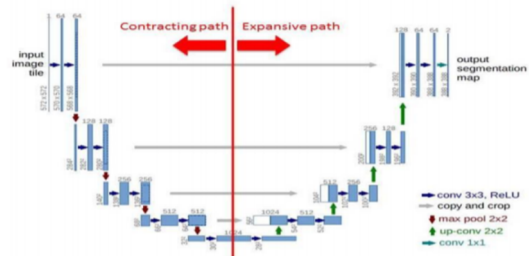


Fig 1: Network Architecture

1.2 Purpose

The Main objective of the proposal is to use the method of convolutional neural networks for segmentation of liver from CT. The early extraction of liver helps the diagnosticians in the treatment of liver related diseases

2 Materials and Datasets

The dataset of CT Scan which is chosen for this is the 3D IRCAD. This dataset contain the anonymised CT Scan of 20 patients (10 men and 10 women). The images are provided by the authors in DICOM and VTK format in 512x512 pixels. One disadvantage of this dataset for our purpose is that 75% of the patients present an hepatic tumour, which is

not the main objective for segmentation for this post, and may represent a “noise” in the data we are trying to isolate.

As the images from the dataset selected are in DICOM format, we shall use a python library for extracting our data.

The 3D IRCAD dataset also contains true handmade segmentation of other organs such as bones, lungs, liver tumour etc.

2.1 DICOM format

DICOM (Digital Imaging and Communications in Medicine) is commonly used for storing and transferring medical image dataset world wide. The format contains identification and informational tags besides the image itself. The pixel data inside the DICOM file may be compressed using JPEG, JPEG2000, lossless JPEG, RLE and LZW formats.

We use a python library called the dicom for handling and performing operations on the DICOM files.

3 Tensorflow and Keras

3.1 Tensorflow

Tensorflow is machine learning framework. Tensorflow has several structures for developing complex neural networks based on different models such as CNN and RNN. It provides implementation of optimization algorithms, specific NN types (i.e.: LSTM), cross-validation, batch training. It also provides the Tensorboard, which is a tool for visualizing the network graph and follow the training and testing processes.

Tensorflow uses a graph-based approach where the user constructs the graph for the model in which each node represent an operation, input or output. This graph is then compiled for better performance. The graph is attached to a session that may execute its operation on CPUs, GPUs or other network processing nodes. Both hardware device selection and network clustering are easily done by following some manual instructions.

3.2 Keras

Keras is a high-level neural network API that supports Tensorflow and Theano. Keras is responsible for constructing common neural network-based layers, i.e: dense, pooling, flatten, etc. This kind of feature considerably speeds up the development of the model.

3.2.1 Conv2D

This layer creates a convolution kernel that is convolved with the layer input to produce a tensor of outputs. If use_bias is True, a bias vector is created and added to the outputs. Finally, if activation is not None, it is applied to the outputs as well. When using this layer as the first layer in a model, provide the keyword argument input_shape (tuple of integers, does not include the batch axis), e.g. input_shape=(128, 128, 3) for 128x128 RGB pictures in data_format="channels_last".

4 Building the Model

Before building the model we should take care of the input for the model, we need to scale down the 512 x 512 size into 128 x 128 ratio for feeding it to the neural network. We later need to prepare the ground truth and the input and the training and testing split ratio. Here we are considering a 75:25 ratio of training and testing.

4.1 Pre-Process the dataset

At first we need to pre-process the dataset. Our dataset contains a folder called the “masks_dicom” which contains the true hand made segmentations of the organs of interest. We use this as our ground truth to train our model. The “patients_dicom” which contains the CT scans of that respective patient, we use that as the input for our model for segmentation.

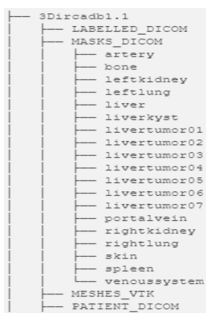


Fig 2: Folder structure

4.2 Model

Our model consists of a 10 layer architecture of convolutional layers. With an additional inclusion of dropout layers for prevention of overfitting and due to the limited information provided by the datasets. It also reduced the training time. We used the “Adam optimiser” and the for the activation function we used “Relu”.

Pooling is an operation that reduces significantly the variance of the data inside a convolution window by selecting a desired property of its region. Pooling is an operation normally attached after the convolution itself and the activation function (i.e.: sigmoid, ReLU, etc.)

The dropout is another operation that intends to avoid overfitting. The dropout layer randomly zero an unity with a specified probability, thus, at least theoretically, helping the network to not rely only in a small subset of values, then, avoiding overfitting.

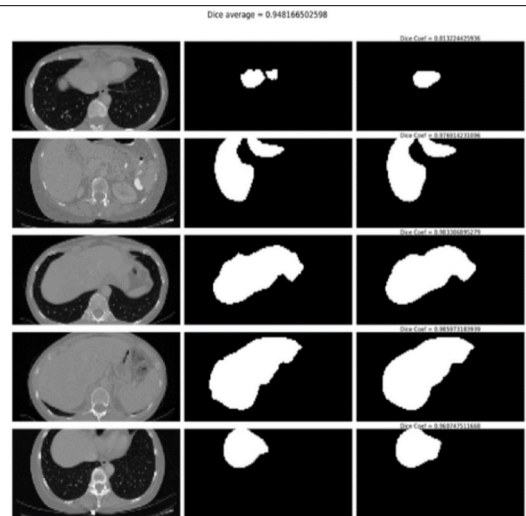
4.3 Sørensen–Dice coefficient

The Sørensen–Dice coefficient is used to compared two different statistical samples, but it is also used on image processing areas to match similarity between to binary images.

The loss function is given by the negative of the Dice coefficient. As it was necessary to use the calculation of Dice coefficient on different moments, considering plotting, logging and the training itself, there are three variations.

5 RESULTS

By varying the number of epochs and the train-test split obviously affects the result of the training. One of the best outputs i.e dice score of 0.94 for liver segmentation used 250 epochs, which uses 75% of total number of images for training and remaining for testing purpose that contains the liver.



Results above. The leftmost column is the CT Scan image, The middle column is the real segmentation and the rightmost column is the segmentation generated by our 10-layer U-Net.

Fig 3: Segmentation

5 Further works

The U-NETS helps us achieving the best of segmentation. We can increase the number of epochs and layers for achieving a better result than we have obtained here. Also since the 3DIRCAD dataset also gives true segmentation of the other organs and tumours we can also work on the segmentation of them with considerable enhancements.

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