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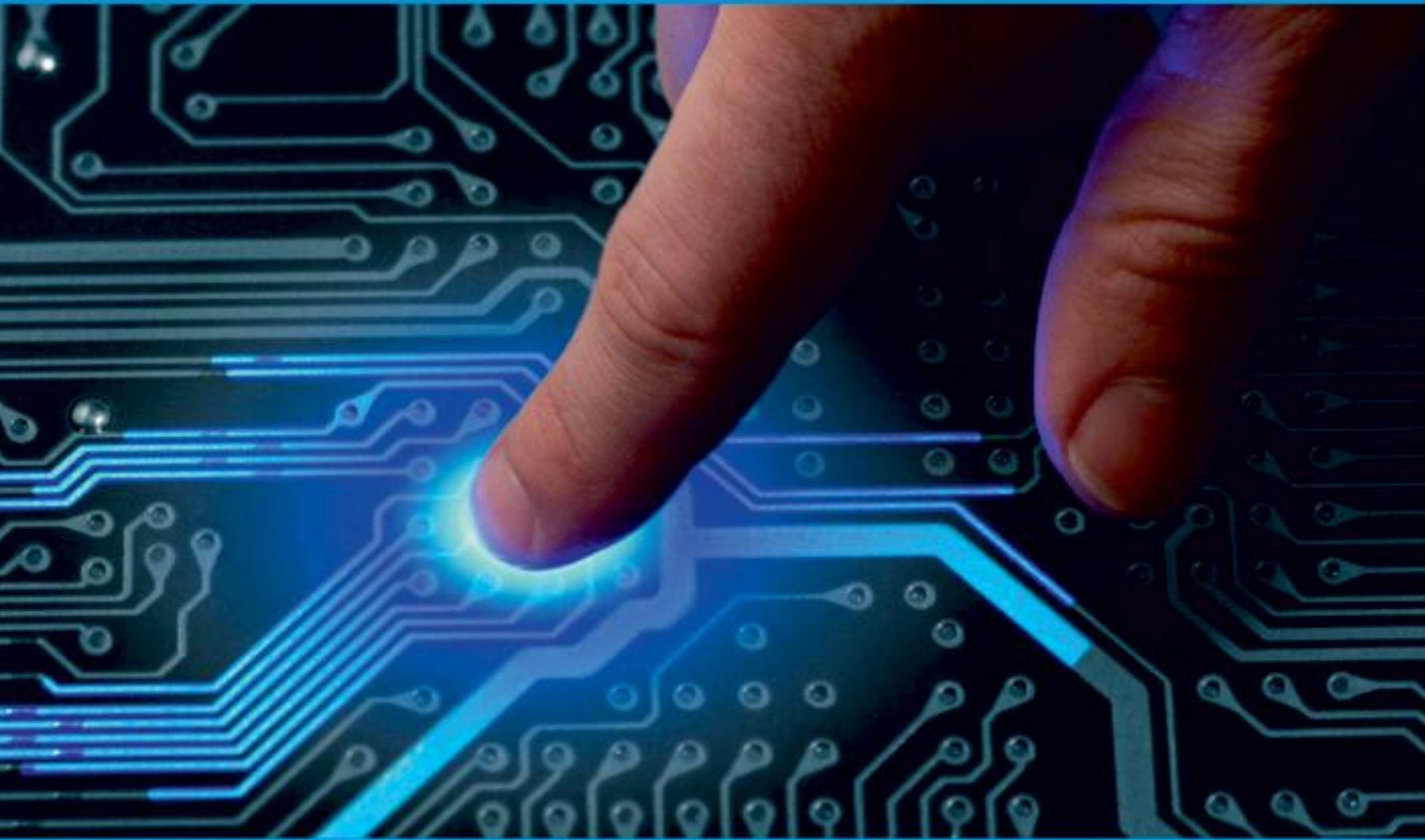

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Nuclei Detection Using U-Net

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ABSTRACT: Image segmentation has proved its ability in medical field. Several diseases are diagnosed at early stages through image segmentation. The image segmentation architectures provide effective and reliable results to researchers in disease diagnosis hence, researchers find it useful to automate the diagnosis process. By automating the process of diagnosis we could help unlock cures faster – from rare disorders to common cold. In this paper we present the review of one such image segmentation architecture called U-Net and the role of this architecture in medical image segmentation. Finally using U-Net architecture we automate the nuclei detection process by finding the nuclei in divergent images to advance medical discovery.

KEYWORDS: Image segmentation, architecture, diagnosis, nuclei, U-Net.

I.INTRODUCTION

Identifying the cells' nuclei is a primary step for most analyses because most of the human body's 30 trillion cells contain a nucleus full of DNA, the genetic code that programs each cell. Identifying nuclei allows researchers to identify each individual cell in a sample, and by measuring how cells react to various treatments, the researcher can understand the underlying biological processes at work. This segment forms the basis of this paper. Segmentation helps to simplify the image into something that can easily be analyzed. Segmentation techniques are used to isolate the desired object from the image in order to perform analysis of the object. Deep learning requires several images for training. Since, biomedical images are expensive. There is need for better image segmentation techniques. So, an architecture named U-Net is developed which fixes the limitations caused by previous architectures and is advantageous over the existing architectures. It is specifically designed to perform semantic segmentation. In semantic segmentation all the pixels representing same class are painted alike. "U-Net" doesn't need multiple runs to perform image segmentation and can learn with very few labelled images. U-Net is more efficient than other convolutional models, in terms of architecture and in terms of pixel-based image segmentation formed from neural network layers. U-Net perform the task with very low errors.The architecture consists of a contracting path to capture context and a symmetric expanding path that enables precise localization. For this paper we use large segmented nuclei images acquired under variety of conditions and detect the nuclei from the existing images and provide accurate results using U-Net architecture.

II. LITERATURE REVIEW

Many deep learning tools have developed for medical applications in past few decades. Some of them include Auto-encoders, Deep Belief Net, Convolutional Neural Networks, Recurrent Neural Network, Reinforcement Learning to Neural Networks. Among these, Convolutional Neural Networks has gained more popularity because of its high performance and accuracy. U-Net, an extended architecture of Convolutional Neural Networks, is a Fully Convolutional Networks (FCN) and a powerful deep learning model used mainly for biomedical image segmentation. It has been published in 2015 MICCAI with more than 3000 citations by November 5 2018. The growth of U-net papers since 2017 has made it a premier deep learning technique in medical image diagnosis.

The U-Net architecture fixes most of the previous approaches flaws and bring additional advantages. This architecture takes full image as an input and generating a full image as an output. The output image only contains 0 and 1 which delimited the background from the object we want to discern. Also, this architecture contains links between its first "increasing features resolution/decrease image resolution" and its second "decreasing feature resolution/upscaling image resolution". These links consist of saving snapshots of the weights during the first phase of the network and copying them to the second phase of the network. This makes the network combining features from different spatial regions of the image and allows it to localize more precisely regions of interests.

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III. ARCHITECTURE

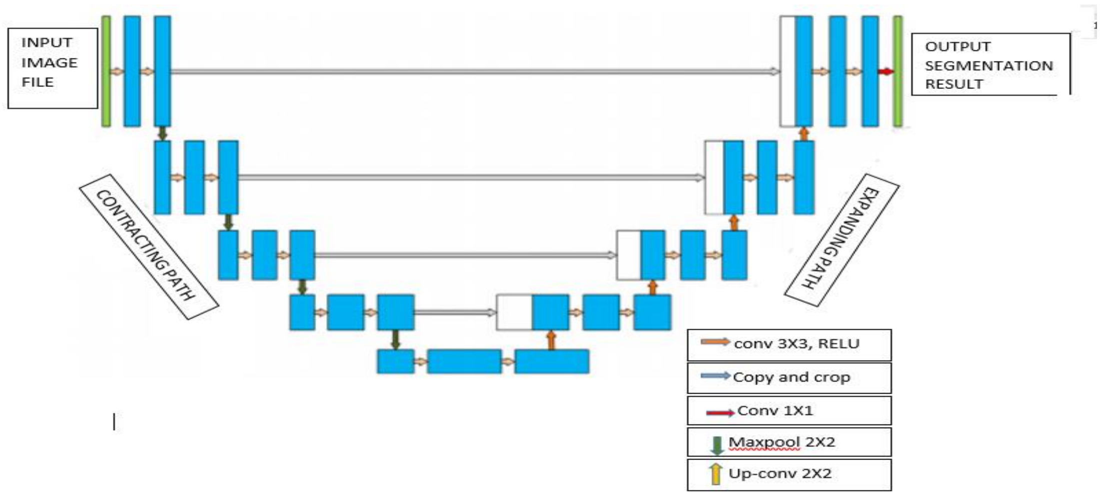

Fig1: UNet Architecture

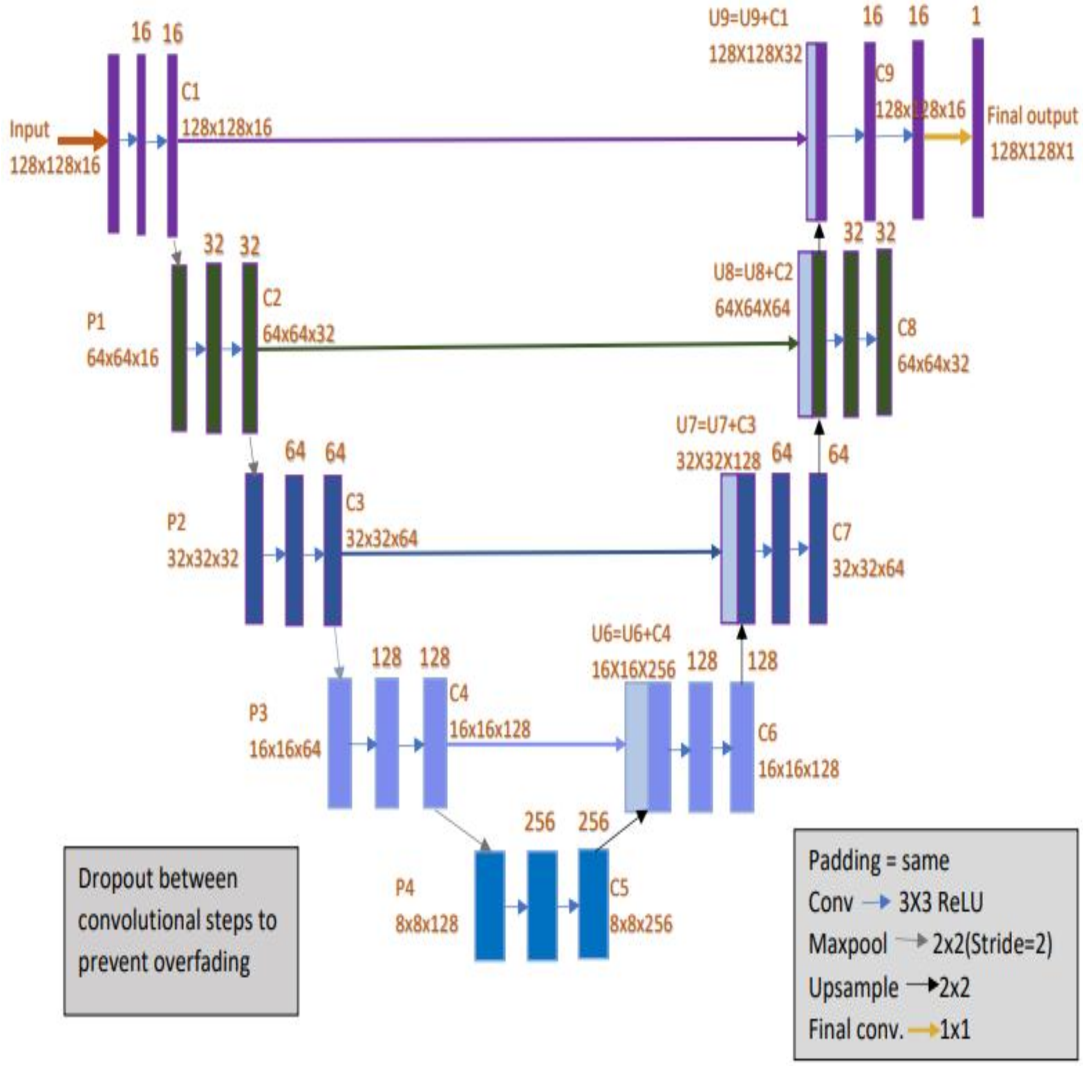

Fig 2: U-net use case diagram

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We have applied the designed architecture on dataset containing large number of segmented nuclei images.

IV.WORKING

It's called U-Net because it looks like U. The architecture itself contains two paths the path on the left where it's called contraction path or encoder path and on the right it is the expansion or decoder path. In between the data on left is concatenated with that on right this gives the benefit of obtaining localized information and makes semantic segmentation possible using U-Net. The input resized images of dimensions 128X128X3 are given and a feature space of 16 is added to the images convolutional operations using 3X3 matrix are performed and the output would be an image with dimensions 128X128X16 is obtained and padding is performed to make the output image same as input image. The next is to perform max-pooling using 2X2 and stride 2, the output becomes 64X64X16 the process is repeated all the way until the dimensions are 8X8X128 and an output image of dimensions 8X8X256 is obtained and then we perform up-sampling using similar parameters expect for concatenation is performed on the image and the final output would be an image with dimensions 128X128X1. In between these steps a drop out is performed by randomly selecting 10% of images and drop them this is done in order to prevent over-fading. The task here consists of taking a full image as an input and generating a full image as an output. The output image only contains 0 and 1 which delimited the background from the object we want to discern.

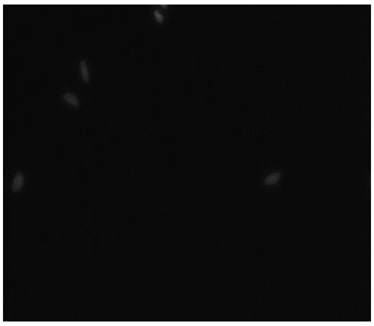
V.TRAINING AND RESULT

The data set contains large number of segmented nuclei images in the train data set along with their masks which contain one nuclei. The test data set contain images and is applied on the architecture for testing and the corresponding mask of random image selected from the test data set is plotted.

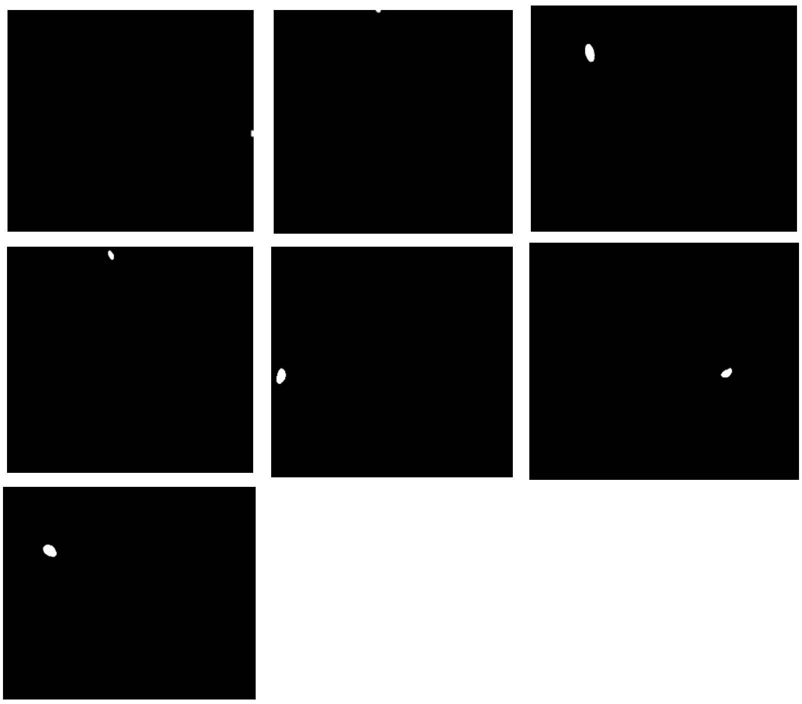
Data Set	No. of images
Training set	670 images along with corresponding mask
Testing	65 images

Training Set:

Image



Corresponding masks



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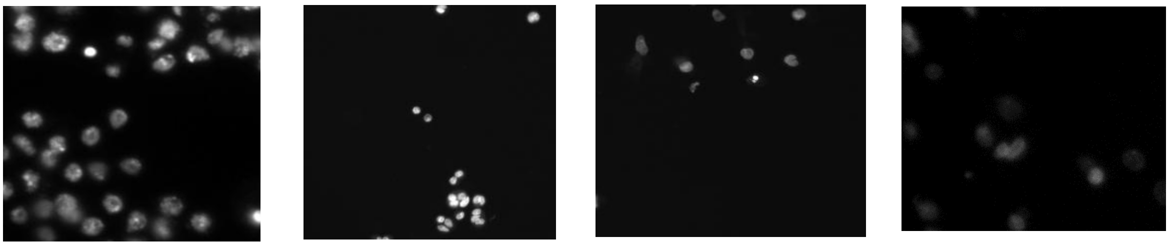
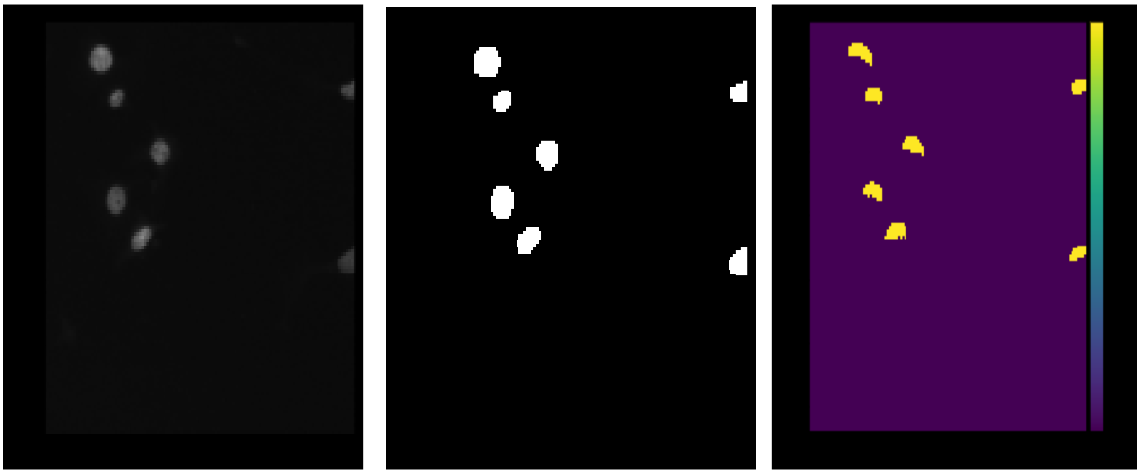
Testing images



RESULT ANALYSIS



(a) (b) (c)

Fig 3: Nuclei detection (a) raw image (b) generated segmentation mask (c) map with a pixel wise loss weight to force the network to learn the boarder pixels

The raw image is randomly selected from the set of images from the testing folder in the dataset and its corresponding mask is generated by the U-Net architecture and plotted along with its pixel wise loss map is plotted for analysing boarder pixels.

VI. CONCLUSION

Image segmentation is an important problem and every day some new research papers are published. U-Net contributed significantly in such research. U-Net is able to do image localisation by predicting the image pixel by pixel and the author of U-Net claims in his paper that the network is strong enough to do good prediction based on even few data sets by using excessive data augmentation techniques. Many new architectures are inspired by U-Net. But still, there is so much to explore. There are so many variants of this architecture in the industry and hence, it is necessary to understand the first one to understand them better. There are many applications of image segmentation using U-Net and it also occurs in lots of competitions.

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