iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 **Issue:** VI **Month of publication:** June 2022

DOI: https://doi.org/10.22214/ijraset.2022.43774

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue VI June 2022- Available at www.ijraset.com

MRI Brain Tumor Segmentation Using U-Net

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Abstract: ***A brain tumour is a common but very deadly disease commonly found in adults. A tumour on the brain grows abnormal cells in the brain, which can cause cancer. The most common way to detect brain tumours is Magnetic Resonance Imaging (MRI) scans. From MRI images, information about abnormal tissue growth in the brain is observed. Early detection of brain tumours plays an important role in improving the chances of treatment and increasing the survival rate of patients. There are many techniques for detecting brain tumours in MRI images. These methods face challenges such as locating vegetation. Finding tumours in the brain is an important part. The clinical procedure involves diagnosing MRI images by hand which is complicated, time-consuming and often human error. Semantic classification is often used in medical modelling to identify the exact location and posture of structures in the body and is important for proper diagnosis of medical problems and their treatment. We propose a model that uses the recent success of in-depth learning methods of semantic separation. In Deep Learning, the convolutional neural network (CNN, or ConvNet) is a segment of sensory networks, which are widely used to analyse visual images. The main algorithm used here is U-Net. U-Net is a convolutional neural network created by the division of biomedical images.***

I. INTRODUCTION

A. Motivation

because the technology is getting higher on a everyday foundation, there is usually a better and powerful solution for each problem. despite the fact that matters are sophisticate to make they are smooth to recognize and use.

B. Problem Statement

As our technology is enhancing drastically, each trouble, now has a better and powerful answer. A mind tumor is a universally recognized medical situation however does now not have a entire image-sharing technique. A mind tumor is deadly, but it's far a commonplace sickness currently seen. MRI scans are currently getting used to diagnose tumors. As we recognize the simplest known prognosis to this ailment is executed by using a certified specialist / neurologist. those MRI reports are notably dependent on human sources, time ingesting and liable to mistakes. here is the trouble we intend to clear up to attempt to separate the photograph, with very little blunders we use the default device.

1) To solve the problem of segmenting the image/, with a very small error using an automated system.
2) To apply the U-net algorithm which is an extension of Convolution neural networks (CNN) for image segmentation.
3) We aim to provide a system with minimal error and high accuracy.

II. OBJECTIVES

A. Convolution Neural Networks (CNN)

CNN is a form of neural community model which allows us to extract better representations for the photograph content material. not like the classical photograph reputation wherein you outline the photograph capabilities yourself, CNN takes the picture's uncooked pixel facts, trains the version, then extracts the functions robotically for higher type. Convolution neural network comprises n basic building blocks, namely:

Convolution layers
Pooling layers
Fully connected layers

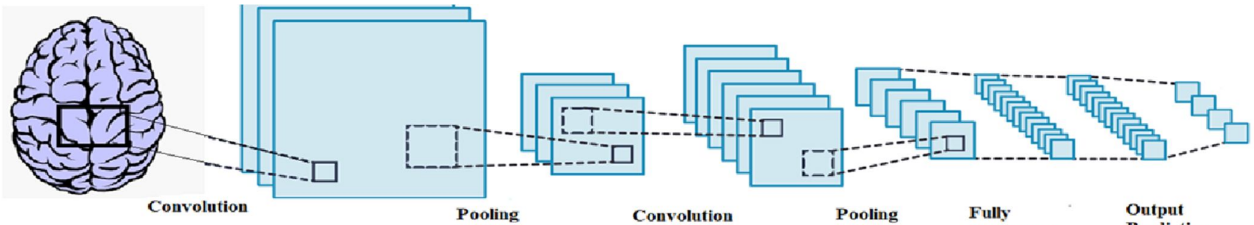


Fig. 1. CNN Architecture

B. U-NET

1) U-net algorithm is used to identify/localize the tumor in the given image with comparably high accuracy than other algorithms.

2) The shape of the so formed architecture is in the form of a 'U' and hence the following name

3) Its architecture can be broadly thought of as a down-sampling network followed by up-sampling network.

The idea of the UNET is to localize the area of the required features in the image by the process of up-sampling the obtained features through the conventional convolutional neural networks.

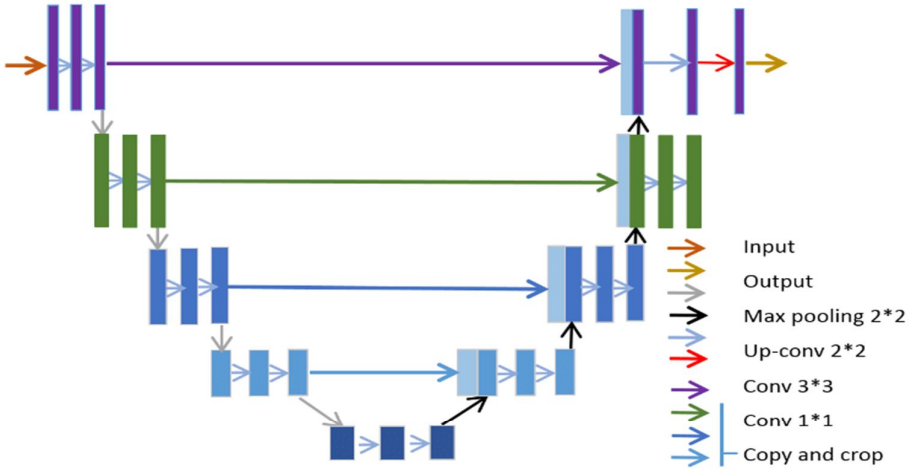


Fig:2 Architecture of U-Net

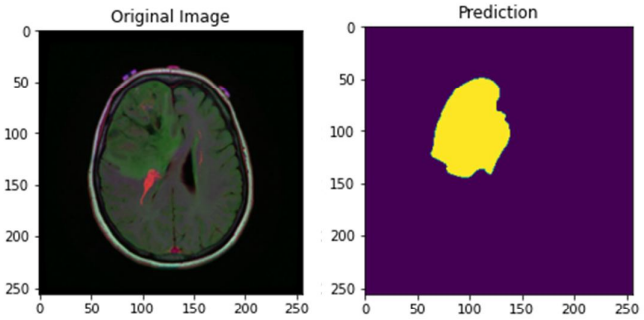
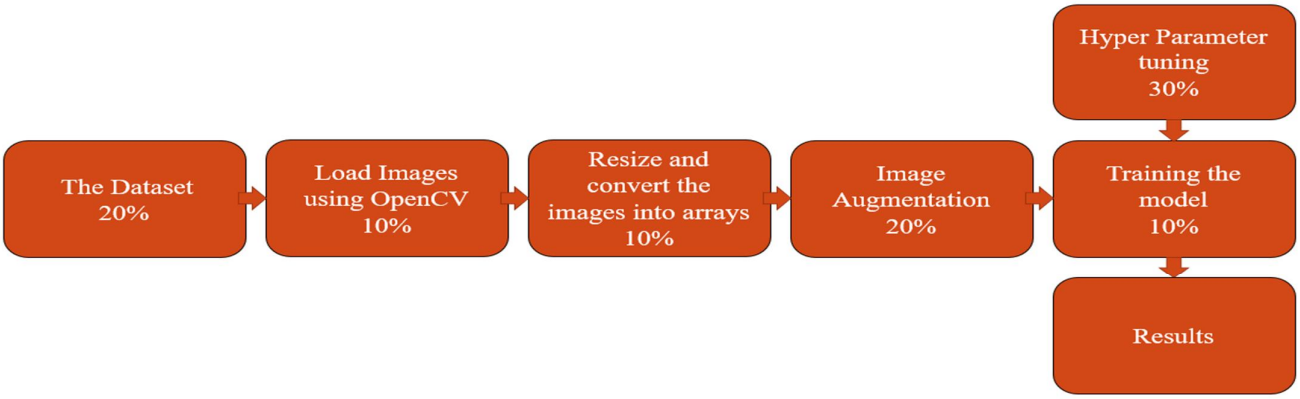


Fig:2.1 Input Fig2.2 Output

III. BLOCK DIAGRAM



IV. SOFTWARE AND TOOLS

- Dataset

The images were obtained from the Cancer Imaging Archive (TCIA). It consists of around 3000 MRI images along with a mask specifying the ground truth. That is the original region of the tumour

- Programming language: Python
- Libraries: TensorFlow, Keras, OpenCV
- Platform used: Kaggle
- GPU Accelerator :16 GB
- CPU ACCELERATOR: 8GB

A. Python

Python was created by Guido van Rossum. Guido van Rossum started to develop Python in 1989. Python is a completely easy programming language so even in case you are new to programming, you can examine python without going through any troubles. Python is a extensively used preferred-cause, high degree programming language. It turned into created with the aid of Guido van Rossum in 1991 and further developed by using the Python software basis. It was designed with an emphasis on code clarity, and its syntax allows programmers to specific their standards in fewer traces of code.

Python is an excessive-level, interpreted, and popular-reason dynamic programming language that focuses on code clarity. It has fewer steps when compared to Java and C. It turned into founded in 1991 with the aid of developer Guido Van Rossum. Python ranks among the most famous and quickest-developing languages within the global. Python is an effective, flexible, and clean-to-use language. further, the network is very energetic there. its miles used in lots of businesses because it helps a couple of programming paradigms. It also plays automated memory management.

B. Tensor Flow

TensorFlow is a unfastened and open-source software program library for machine learning and artificial intelligence. it is able to be used throughout quite a number tasks however have a selected consciousness on schooling and inference of deep neural networks. TensorFlow turned into advanced by means of the Google mind group for inner Google use in studies and production. The preliminary model changed into launched underneath the Apache License 2. zero in 2015. Google launched the up-to-date model of TensorFlow, named TensorFlow 2.0, in September 2019. TensorFlow can be used in a huge type of programming languages, maximum extensively Python, in addition to JavaScript, C++, and Java. this adaptability lends itself to more than a few applications in lots of one-of-a-kind sectors.

C. KERAS

Keras is a high-level neural networks API, capable of strolling on pinnacle of TensorFlow, Theano, and CNTK. This platform enables the user to speed up the experimentation through a high degree, consumer-pleasant, modular and extensible API. You can also use CPU and GPU to run Keras. Keras has become better and is taken care by means of Francois Chollet and it is now a part of the TensorFlow middle, and now it is TensorFlow's desired high-degree API.

D. OpenCV

OpenCV is a well-known open-source software program that has computer vision and machine gaining knowledge of software that turned into built by means of Intel. It gives a not unusual infrastructure for packages associated with pc vision and its related fields. Open CV enables to enhance the velocity of actual-time device popularity of pictures, gadgets, and video processing applications.

To have an outline of ways OpenCV works, let's talk those critical topics: pc imaginative and prescient, OpenCV's related programming languages, and OpenCV applications — to have an in-intensity information of this powerful library. Our eyes send signals to our mind and it analyses what we see; we are able to apprehend faces, items, actions, and determine if something is right or terrible on a given state of affairs. in the equal manner, laptop vision (CV) desires to recreate what our eyes do. It gathers statistics from almost all of the electronic gadgets within the shape of digital pics or movies. it is able to additionally examine complicated photos, execute comparisons, and set up the differences. There can be a big increase inside the generation we use with the help of laptop vision (CV) because it has advanced from the idea of truth. computer vision has been a lifestyles saver for plenty agencies and groups and additionally to many other individuals. agencies use laptop imaginative and prescient for OCR, imaginative and prescient biometrics, object popularity, computer graphics, 3D printing and picture seize, sports, smart cars, scientific imaging, and plenty of others.

From an IT professional's point of view, they are searching for to automate duties concerning visualization. as a consequence, it fuelled huge traits resulting in a big interest from both entrepreneurs and software improvement providers. these are people from

all avenues in existence with special ability stages who collaborate to smoothen the friction among productivity and commercialism. additionally, they intention to find the balance of the complexity of computer imaginative and prescient and pitch it flawlessly to the arena. Laptop vision pursuits to make our lives less difficult because it may be implemented in almost all areas. those applications create heroes inside the world of computing — heroes which include customers and software developers. The clients who want to clear up low-level CV issues the use of forward-wondering and courageous processes. Plus, the notably proficient builders cohesively expand CV systems over computer systems and different device.
There are many similar implementations in the market, but what makes this design unique is the scope of development. As newer and better technology is being brought into the market, there are many ways to make it even more advanced and secure.

V. RESULT AND DISCUSSION

The parameters used in training the U-Net model for segmentation of the brain tumour are given in table 5.1.

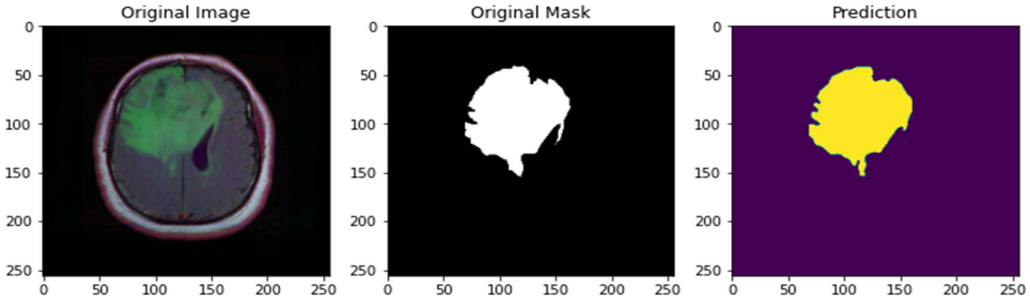
Parameters	Value
Input size	(256,256)
Batch size	16
Learning rate	$5*10^{-3}$
Optimizer	Adam
Epochs	150
Loss function	$L_{Dice}+L_{IOU}$

The above table represents the value of the hyper parameters such as batch size, learning rate the optimizers and loss functions used to train the Unet. On training the model with the above parameters, the output metrics obtained on the training and validation datasets are given in the table 5.2

Metrics	Readings
Loss	-0.924503
Validation Loss	-0.892947
Binary Accuracy	0.998430
Validation Binary Accuracy	0.998059
Dice coefficient	0.924446
Validation Dice coefficient	0.892947
IOU	0.862625
Validation IOU	0.810502

Table 5.2 Output metrics obtained on training and validation datasets

The above table represents the final metrics of the output from the trained neural network the output metrics are divided into
The below figures 5.1 to 5.3 are some of the examples of comparison of the outputs of the segmentation model built. In figure 5.1.a is the input image (MRI scan image) given to the neural network to segment the region of tumour.
And figure 5.1.b is the ground truth that is the region which the tumour is present to be known which is already known .figure 5.1.c is the region predicted by the built model.



(a) (b) (c)

Figure 5.1 comparison of the tumour in original mask and the predicted tumour region

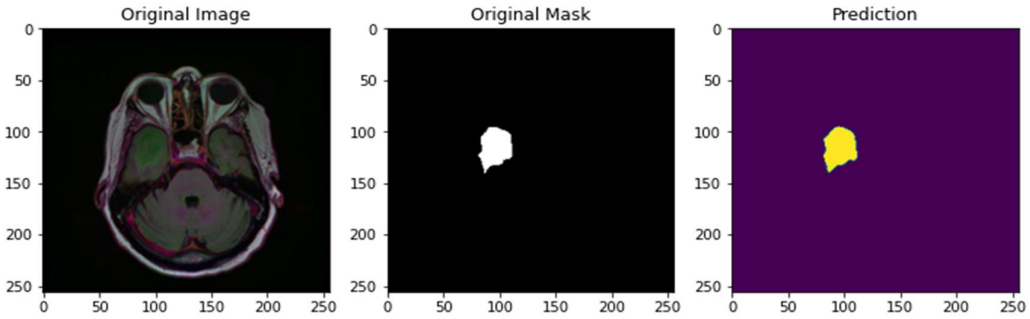


Figure 5.2 comparison of the tumour in original mask and the predicted tumour region

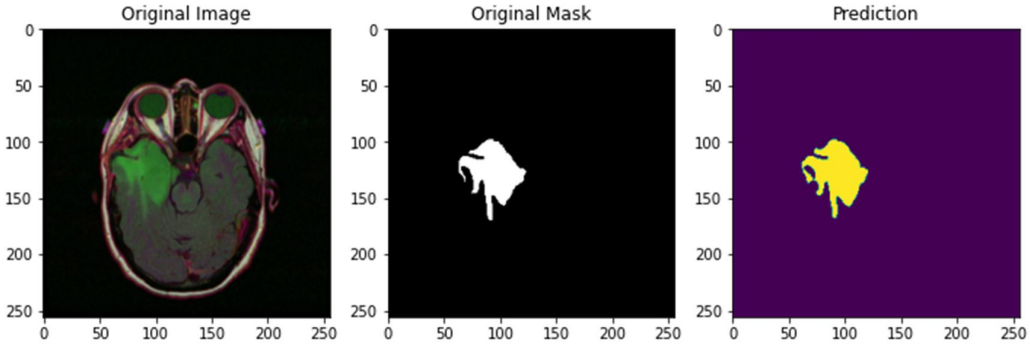


Figure 5.3 comparison of the tumour in original mask and the predicted tumour region

VI. CONCLUSION

it's far crucial in brain tumour segmentation to section out the brain tumour with excessive accuracy if it's far for use in a medical setting. Deep learning segmentation might be used as a 2d-rater for the undertaking of segmentation if high precision may be ensured. The proposed U-net architecture/design turned into evaluated at the dataset gathered from 'The cancer Genome Atlas' (TCGA) and 'The most cancers Imaging Archive' (TCIA). The segmentation effects are 0.86 at the IOU and 0.92 on the dice_coefficient as proven in table no.

VII. FUTURE SCOPE

More complex algorithms like unet++ resnet, resnet ++ or transfer learning techniques to improve the models feature extraction capabilities

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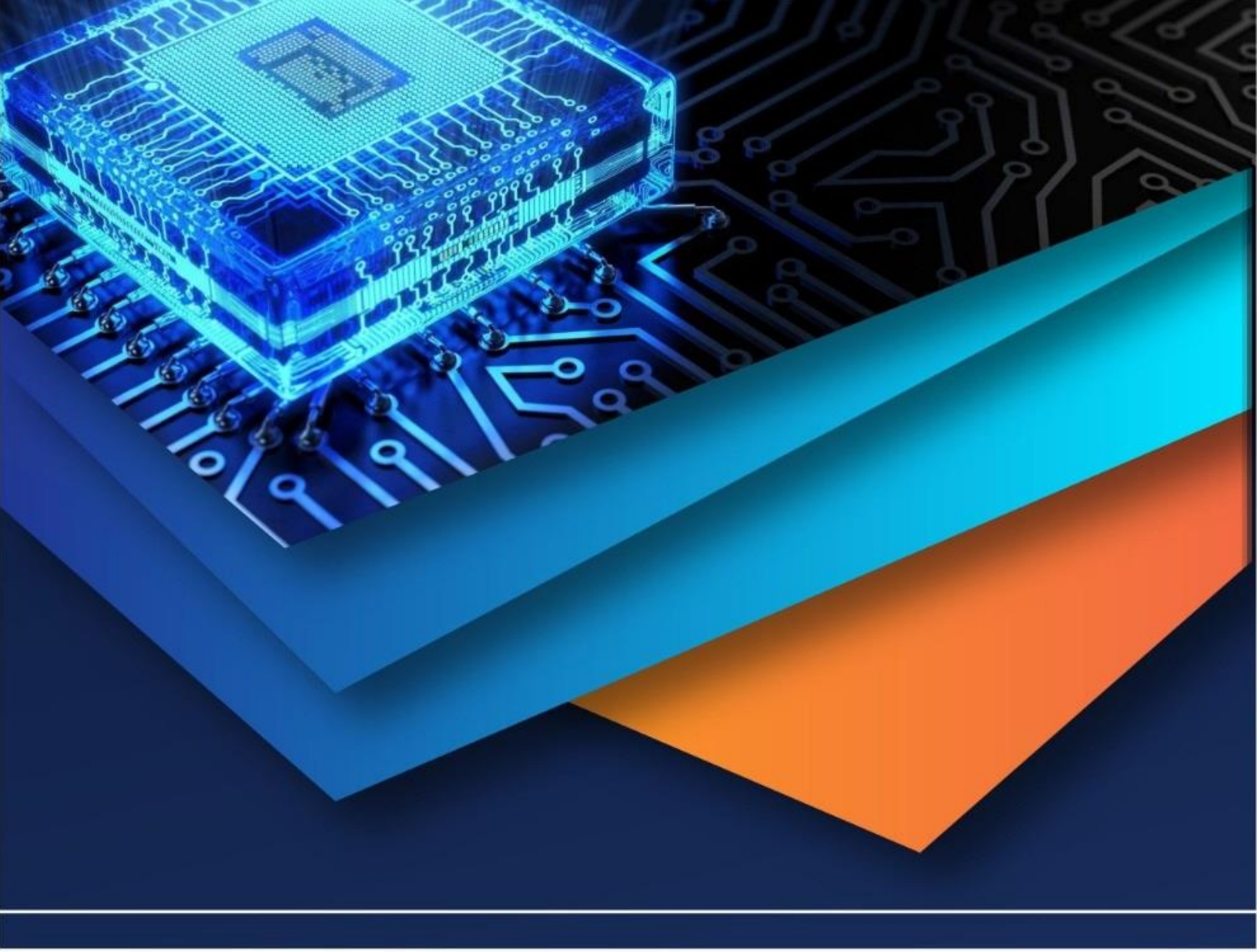

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