A Generative Adversarial Network Based Segmentation and Classification using Deep CNN: Systematic Review

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Abstract
To become improved in the field of Deep Learning it is a province system which is fully depended on learning methods and it upgraded one. It possesses to inspect closely to computer algorithms. In this detecting tumor system is one of the uppermost to confinement training tissue from the normal brain function tissue. It contributing numerous discipline such as medical image analysis, facial recognition system, virtual assistants, investment modelling like many applications its paly a various role to get accurate detection of the image. The motivation to this study is to layout an investigation based on deep learning network analysis. From this segmentation and classification is established to impose deep convolutional neural network and fully connected layer based Generative Adversarial Network (GAN). The model makes unfamiliar data that bear a resemblance training data in generator (generate images) and discriminator (it is classifies real and fake image). After a while GAN based segmentation and classification handout some predominance performance are confer. A good many multitude people were worked in this GAN based tumor segmentation and detection. From this most of the researches failed to get more accuracy in this technique. To summarize the state of art to help out experimentation in succeeding superintendence.

Keywords: Deep Learning, Generative Adversarial Network (GANs), Convolutional neural network (CNN), Medical imaging

1. INTRODUCTION

1.1 Analytics

In India Brain and other nervous system cancer is the 10th leading cause of death for men and women. Brain tumors kill more children and adults under the age of 40 than any other cancer, reported from WHO 2019. Subsequently the cancer cases rise 10% in 4 years to 13.9L as per The Hindu and Times of India report in 2020. The National Cancer Registry programme 2020, cancer cases were estimated at 12.6L in 2016 and 13.6L in 2019. Already cancer impacts more women than men in terms of overall numbers going by the data from 2016 and it projected that this will continue in the years to come. The report released by the Indian Council of Medical Research and National Cancer for Disease Informatics and Research, Bengaluru.

The projects that the number of male cancer cases this year would be 6.8L while the number of women impacted is pitched at 7.1 L. The numbers are projected to reach 7.6 L for men and 8.1 L for women in 2025. The above information was collected from 28 population based cancer registries and 58 hospital based cancer registries.
Table 1: Courtesy: Report on National Research Funding, Brain Tumor Research

| Deaths England and wales | Breast | Leukaemia | Brain | All cancers |
|--------------------------|--------|-----------|-------|-------------|
| 2002                     | 11,557 | 3,841     | 2,908 | 136,331     |
| 2015                     | 10,266 | 4,142     | 3,684 | 143,664     |
| Increase                 | -11.2% | 7.8%      | 26.7% | 5.4%        |

1.2 Reason for this study

Generally our human bodies system found in numerous biological functions, which is accomplished particular action for everyday breathing. i.e when the system function is going wrong (it mean a unwanted growth of particular part in the body)and affects the various parts in the human body due to the behavioural, genetic, environmental risk factors.

Based on the risk factors now days the number of cases were increases. Main reason for these reasons may be exaggerated of ultraviolet exposure, alcohol, genetic, hormonal drugs, excessive sun exposure, and radioactive materials.

In this Generative Adversarial Network (GANs), have meet with significant wide awake recently. GAN has been used in many imaging applications. To assess and differentiate GANs training and test data used. According to this different parameter were discussed to evaluate the performance of GAN based Deep CNN is highlighted in this manuscript and then other field of computer vision and machine learning also contributing more in researchers.

2. RELATED BACKDROP STUDY

2.1 Manual study

- Manual detection of brain tumor requires human Interaction and Time Consuming.
- The presence of Noise, Inhomogeneity, poor images contrast.
- Inflammation, exerting pressure on parts of brain and increasing pressure within the skull.
- The report to be damaged or else missing and it is takes time to reach the Doctor.

2.2 Classification of brain tumor:

There are various types of tumor were predicting in current scenario.from this different case study majorly segregated into two ways in the brain tumor.
3. LITERATURE REVIEW

In Generative Adversarial Network session is inquiry about defined classification and segmentation methods in cancer. Past few years its play a major role to identify the cancer, manual detection process takes more time to recognize and identify the location of tumor instead that using automated version to find the various cancers using GAN in deep neural network. Deep learning gives huge progresses in many fields, in this paper fully focused on systematic analysis in the deep learning network based model.

**Machine learning**

\[
\text{Input data} \rightarrow \text{Feature Extraction} \rightarrow \text{Classification} \rightarrow \text{Output data}
\]

**Deep Learning**

\[
\text{Input data} \rightarrow \text{Feature Extraction} \rightarrow \text{Classification} \rightarrow \text{Output data}
\]

**Two deep Inference Models**

- **Predictive**
  - Predict the category / Class of an object by learning mode
  - Ex: CNN

- **Generative**
  - Generate a new object that closely matches to those in a limited training set by closely approximating the underlying (but known probability distribution of set of objects)
  - Ex: GAN

**Generative Adversarial Network**

\[
\text{Real world} \rightarrow \text{Observations} \rightarrow \text{Model} \rightarrow \text{Synthetic observations + Density estimation} \rightarrow \text{Generative goal of modelling}
\]
Generative Adversarial Network Architecture

**GAN** contains two sub models one is generator and another one is discriminator.

**Generator** = It is used to **generating new examples**

**Discriminator** = It is used to classifying whether given data is true or not.

Changhee Han et al [1] focused on to generate synthetic based multi-sequence brain Magnetic Resonance (MR) images using Generative Adversarial Networks (GANs). Yufei Liu et al [2] study of cancer staging: GAN based augmentation for AI generation.it is effective utilization of deep learning combined with generative adversarial network (GAN). The samples are segregated into training and test set. The systematic results are verified, this new approach generate a good accuracy than available methods.in this study to transform the classical data into deep learning method based on data augmentation. This set of scenario application used for new information of artificial intelligence based on DL.

In this [3] paper proposed GAN based brain tumor by semantic segmentation. Automated segmentation is very important task in tumor and also gives different challenges in current scenario due to the size, shape, location and contrast. End to end educable architecture used to segment through GAN for BraTS 2017. Fully Convolutional neural networks (FCNs) is segmented with help of discriminator and generator in the segmentation maps. This prediction output depended on deep learning techniques. Upcoming days they have planned to improve network by RNN, this work can be improved as GAN for 3D image segmentation.

Deepks et al [4] expounded a system based on a multiscale gradient GAN to synthesis images for data argumentation. This classification problem is rectified with help of Convolutional Neural network, in this to figshare data set is used to improve the classifier performance. Ahmed Elazab et al [5] put forward tumor growth prediction using GP- GAN. In this study a modified 3D U-Net architecture is designed. The new method is used to train and test specific images to get improved performance of the given system. A GAN based medical image data augmentation for performance increment in CNN, in this model limited number (182) of datasets are used to get accuracy [6]. Ahmed Elazab et al [7] Generative Adversarial Networks (GANs) from longitudinal MR images using GP – GAN. In this a novel based objective function is used in stacked conditional GANs.

**GAN: General diagram**

![Fig1: General diagram for GAN](image-url)
GAN Training model

- Fed the real input images from training set
- Train the both real and fake images
- Generator – Generating new images
- Discriminator – classify whether the given data is fake or real
- Finally, output sample generated

Additional implementation

- CNN based classification (SVM) give more accuracy in output data.
- DNN + GAN – combined network
- Multi Model, PGGANs – Data Augmentation
- 3D conditional GAN frame work (CT – GAN) Network

3.1 Analysis Review

| S.No. | Techniques Used | Performance Evaluation | Dataset |
|------|----------------|------------------------|---------|
| 1    | Generative Adversarial Network (GAN) + Deep Neural Network (DNN) | F-measure -0.7007, G-mean -0.6839, Accuracy - 0.7097 | SMOTE (various imbalanced data) |
| 2    | Fully Connected Network (FCNs) + Different Regression techniques (Super Vector Regression, Polynomial Regression) | Dice coefficient -0.80, Sensitivity -0.78, Specificity -0.90 | BRATS 2017 |
| 3    | Conditional Cycle Generative Adversarial Network (cCGAN) + Haematoxylin (H) and Eosin (E) stained images | TN -86%, TF -39%, HN -76%, HB -99%, Overall – 44% | Colorectal liver Metastases (CRLM), hospital name not mentioned. |
| 4    | Multi-Scale Gradient - GAN (MSG-GAN) + Deep Convolutional Neural Network (CNN) | Accuracy – 88.7 | FIG SHARE |
| 5    | 3D generative adversarial networks (GANs), named GP-GAN | Jaccard Matrix - 78.97%, Dice coefficient - 88.26% | BRATS 2014 |
| 6    | Generative Adversarial Network + Deep Learning + Data Augmentation + Convolutional Neural Networks + DCGAN architecture | 85.7% sensitivity 92.4% specificity | Dataset from hospital |
| 7    | Generative Adversarial Networks (GANs) + synthetic multi-sequence brain Magnetic Resonance (MR) images | DCGAN(128 × 128), Accuracy – 70%, WGAN(128 × 128), Accuracy – 64% | BRATS 2016 |
| 8    | Multi-Conditional GAN (MCGAN) + Lung Nodule Detection Using 3D Faster RCNN | Accuracy – 79% | American College of Radiology, Lung Image Database Consortium image collection (LIDC) dataset |
| 9    | Synthetic Medical Images using | Classification Accuracy - | Alzheimer’s Disease |
| Generative Adversarial Networks (GANs) + Deep Convolutional Generative Adversarial Networks | 71.45% | Neuroimaging Initiative (ADNI) database |
| Progressive Growing of GANs (PGGANs) + PGGAN-based Data Augmentation (DA) | Accuracy -91.08 sensitivity - 86.60 specificity -97.60 | BRATS 2016 |
| Residual Cyclic Unpaired Encoder-Decoder Network (RescueNet) | Dice coefficient -0.87, Accuracy –0.912 | BraTS 2015 and BraTS 2017 |
| Tripartite Generative Adversarial Network (Tripartite-GAN) + synthesizing Contrast-enhanced magnetic resonance imaging (CEMRI) | Peak signal-to-noise rate - 28.8 accuracy - 89.4%, | McGill University Health Centre |
| TumorGAN + Regional Perceptual loss | Accuracy –77.43% | BraTS 2017 |
| Pairwise generative adversarial network (GAN) + deep learning framework | Accuracy –81.03% | TCGA dataset |
| Generative Adversarial Network (GAN) model + | Accuracy - 88.82% | TCGA-GBM ,TCGA-LGG |
| Deep Convolutional Generative Adversarial Network (DCGAN) and AlexNet, termed DC-AL GAN + classification by a support vector machine (SVM) | Accuracy - PsP and TTP after tenfold CV were 0.920 and 0.947 | Wake Forest School of Medicine, Winston-Salem, NC |
| Parasitic GAN + Segmentor S, the generator G, and the discriminator D | Dice core - 0.010-0.035 | BraTS 2015 and BraTS 2017 |

3.2 Work evaluation

The work assessment process can be done on several ways in classification and segmentation methods. There is large number of researchers working in the different techniques to extract their narrow output. From this study, it is viewed that multitude parameter measurement listed as F-measure,G- mean, accuracy, mean, variance, dice coefficient, sensitivity, specificity, Root means square value, relative volume difference, Jaccard Matrix. These are the essential data to produce accurate and approximated output of the classification and segmentation methods.

3.3 Dataset scoop

In Generative Adversarial Network (GAN) based various methods reviewed with particular datasets of brain tumor images. On the ground of different datasets researchers can endorse further. For testing and training purpose various datasets are available from this study. Fig share dataset, BRATS 2016, BRATS2015, BRATS 2014, Lung Image Database Consortium image collection (LIDC)-IDRI American College of Radiology recommends lung nodule evaluation using thin-slice CT scans, SMOTE(This is a type of data augmentation for the minority class and is referred to as the Synthetic Minority Oversampling Technique), Alzheimer’s Disease Neuroimaging Initiative (ADNI) database(adni.loni.usc.edu),GE healthcare scanner and Siemens medical system scanner, with the following parameters: 120kVp, 140-400mAs and 1.25-5.0 mm slice thickness. The different datasets were used by the various investigators to verify their algorithms and techniques. Mostly, the scholars succeed with BRATS 2014, BRATS 2015, and BRATS 2016 datasets.
3.4 Downside

GANs have a countable number of habitual non-success modes. In this research work are actively going to process next level. Analysis has recommend that when discriminator is quality one, then generator training cannot achieve due to vanishing gradients, in sequel discriminator not come up with sufficient details for the generator to build progress.

Advantage
- By using GAN with deep learning generate easily to recognise the system
- GAN generate realistic images and videos (ex: generate new version of images from given input)
- GAN is useful in marketing, hospital, E-business, advertisement and etc.,
- Decrease the needed Direct data(input can be put back with gradients to the discriminator)
- To generate sharp distributions, to achieve the accurate mix.

Drawback
- To take more time to train the data(its take hours)
- Mode collapse
- Some times its turn to make critical to use.
- Generating exact output from text and speech is critical task
- Need different types of data continuously to check the result and train the data (correctly employed or not).
- Physical effects in picture like shadow will become unrealistic.

4. CONCLUSION

A Well-organized tumor identification, segmentation and classification are competitive task to for radiologists and physicians. In medical imaging enormous amount of data are reviewed about of tumor detection based techniques were giving more attentiveness in current scenario. In this Generative Adversarial Network (GANs), have meet with significant wide awake recently. GAN has been used in many imaging applications. To assess and differentiate GANs training and test data used. According to this different parameter were discussed to evaluate the performance of GAN based Deep CNN is highlighted in this manuscript and then other field of computer vision and machine learning also contributing more in researchers. In this paper, investigate various GAN derived models are reviewed with parameter accuracy and datasets.

References

[1] Changhee Han, Hideaki Hayashi, Leonardo Rundo, Ryosuke Araki, Wataru Shimoda, Shinichi Muramatsu, Yuijiro Furukawa, Giancarlo Mauri, Hideki Nakayama.” GAN-Based Synthetic Brain Mr Image Generation”, 2018 IEEE 15th International Symposium on Biomedical Imaging (ISBI 2018), April 4-7, 2018, Washington, D.C., USA
[2] Yufei Liu, Yuan Zhou, Xin Liu, Fang Dong, Chang Wang, Zihong Wang, Research Artificial Intelligence—Article: “Wasserstein GAN-Based Small-Sample Augmentation for New-Generation Artificial Intelligence: A Case Study of Cancer-Staging Data in Biology” online 11 January 2020the authors. Published by Elsevier LTD on behalf of Chinese Academy of Engineering and Higher Education Press Limited Company
[3] Mina Rezaei et al “A Conditional Adversarial Network for Semantic Segmentation of Brain Tumor”Springer International Publishing AG, part of Springer Nature 2020
[4] Deepak S, P M Ameer “MSG-GAN Based Synthesis of Brain MRI with Meningioma for Data Augmentation” UTC from IEEE Xplore:978-1-7281-6828-9/20/$31.00, @2020 IEEE.
[5] Ahmed Alazab, Changmiao Wang, Syed Jamal Saad Kardezi, Hongmin Bai, Qingmiao Hu, Tianfu Wang, Chunqi Chang, Baiying Lei,” GP-GAN: Brain tumor growth prediction using stacked 3D generative adversarial networks from longitudinal MR Images”, Neural Networks, 17 September 2020, Published by Elsevier.
[6] Jyoti Islam and Yanqing Zhang, “GAN-based synthetic brain PET image generation”, Brain Informatics, open access, @2020 Springer.
[7] Shubhangi Nema, Akshay Dudhane, Subrahmanyam Murala, Srivatsava Naidu, “RescueNet: An unpaired GAN for brain tumor segmentation”, Biomedical Signal Processing and Control, © 2020 Elsevier Ltd. All rights reserved.
[8] E. Ramprasath, P. Manojkumar and P. Veena, "Induction motor analysis using labview", Proceeding on International Conference on Electrical Engineering and Technology, vol. 2, no. 5, pp. 498, 2015.
[9] Chenjie Ge, (Student Member, IEEE), Irene Yu-Hua Gu, (Senior Member, IEEE), Asgeir Store Jakola, and Jie Yang, (Member, IEEE), “Enlarged Training Dataset by Pairwise GANs for Molecular-Based Brain Tumor Classification”, IEEE access, February 5, 2020.
[10] Yi Sun, Chengfeng Zhou, Yanwei Fu, Xiangyang Xue, “parasitic gan for semi-supervised brain tumor segmentation”, IEEE, 978-1-5386-6249-6/19/$31.00 ©2020 IEEE.