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Computer Vision in Deep Learning for the Detection of Cancer and its Treatment

[1] Y. Jahnavi *
Department of Computer Science, Dr V S Krishna Govt Degree and PG College (Autonomous), A. U. TDR – HUB, Visakhapatnam, Andhra Pradesh, India
[2] P. Anusha
Dept of Computer Science and Engineering, Guru Nanak Institute of Technology, Hyderabad, Telangana, India
[3] Mudit Mathur
Anheuser-Busch InBev, Bangalore, Karnataka, India
[4] Vidisha Tiwari
Masters in Technology Management, University of Illinois urbana, Champaign, USA

ABSTRACT

Computer vision (CV) is an effective mechanism that helps the computer to see pictorial stimuli from pointing out the edges to having a comprehensive understanding of the complete scenario. In this saga, Deep Learning (DL) has evolved as a crucial part of CV to process data exploiting multi-layered complex structures or layers made of multiple nonlinear alterations. This particular research shows the implementation of DL in the proper diagnosis of cancer and seeking a suitable solution to the disease. DL is an integral part of CV considering a multimodal discriminative model to conduct a diagnosis of diseases, clinical predictions, prognostics, and a combination of such activities. The study upholds the relevance of SSD in having single-shot images with high-resolution pixels to have the images to identify and diagnose the disease. The mechanism leads to early detection of cancer and if the disease gets detected earlier, it can seek a formidable solution, though there are challenges like an alignment of hardware with the CV software, and lack of training of the staff, still DL has the potentiality to create a significant impact on cancer treatment.

Keywords - **Computer Vision (CV), Deep Learning (DL), Single Shot Detector (SSD), Cancer Detection Algorithms**

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I. INTRODUCTION

The development of CV spans decades with the generation of a huge volume of digital data in the various scientific periphery [1-3]. In recent times, DL has created wonders within the dimension of CV, speech recognition, audio recognition, natural language processing, and bioinformatics among others [4]. Accordingly, DL has taken a big leap to exploit medical data and resolve healthcare issues. The sorts of medical data are fairly diverse ranging from maps, videos, texts, magnets, and others [5]. Thus, the DL algorithms are used for medical image analysis to diagnose various diseases like cancer and their effective treatment [6].

The study aims to explore DL in the identification of cancer and its effective treatment using medical image analysis. There exist various other research algorithms on different kinds of datasets [7-21][30][31]. Based on the research aim, the objectives of the study are to understand the impact of DL in medical image analysis, to explore DL in identifying cancer cells and treatment of the patients, and to understand challenges while implementing DL in cancer research and recommend suitable measures for its resolution.

II. LITERATURE REVIEW:

CV has developed its technology with time due to the gradual advancement of DL which is an effective machine-learning mechanism. According to Kim et al., (2019), DL is efficient in facilitating end-to-end learning of the complicated functions from raw data [2]. In this scope, the multimodal discriminative model is worth mentioning for the DL architecture to constitute both image data like convolutional networks, and non-image data like general deep networks. Suzuki (2017) states that learned annotations are useful in diagnosing diseases, clinical predictions, prognostics, and a combination of such activities [1]. Figure 1 shows the Multimodal Discriminative Model in CV.

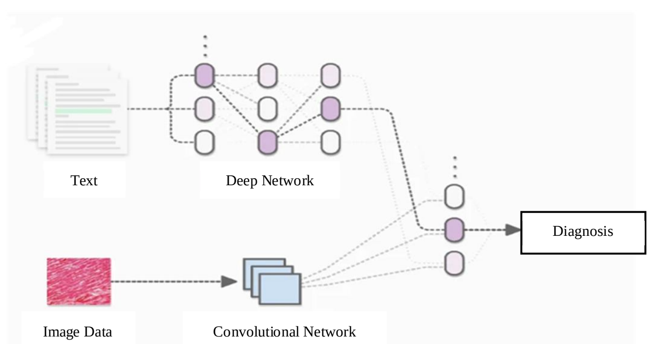

Figure 1: Multimodal Discriminative Model in CV

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III. DL IN MEDICAL IMAGE ANALYSIS

Lu, Wang, Carneiro, and Yang (2019) perceived that CV has gradually made its way into static medical imagery in various streams like pathology, radiology, dermatology, and ophthalmology among others [5]. This has been possible due to the visual pattern-identification mechanism of diagnosis leading to the reconstruction of highly structured images. Puttagunta and Ravi (2021) perceived that medical imaging has not limited itself to mere detection and diagnosis of diseases; it has also led to seeking effective treatment of such diseases. Effective implementation of DL through X-rays, mammography, computerized tomography, and digital histopathology images serves the purpose well [22]. Esteva, Chou, and Yeung (2021) cautioned that DL-oriented CV can be problematic for medical imaging as the images are quite bigger [23]. The giga-pixel images have dimensions around 100,000 x 100,000 pixels against the conventional images at 200x200 pixels [24].

IV. Implementation of DL in cancer diagnosis and treatment

Cai, Gao, and Zhao (2020) stated that DL plays a crucial role in pathology, say in cancer detection and treatment [25]. The pathological analysis takes place owing to a pictorial depiction of tissue samples leading to proper diagnosis and prognostic opinions. Yi, Walia, and Babyn (2019) opined that DL technology using its multi-layered model can identify and chalk out the accurate state of cancer in the body [26]. It uses ultrasonic image identification techniques to properly identify the location of the disease, say the accurate body part. For instance, DL uses ultrasound imaging of breast nodules to detect the morphology and textual characteristics. According to Sahasrabudhe (2020), those nodules in the image help to predict the kind and malignant [27]. This helps the medical practitioners to carry out the sorts of treatment for the patients. The combination of pathology along with radiology and proteomic determination strives for an effective treatment process for the disease.

V. Single Shot detector in cancer treatment

Domingues, Sampaio, Duarte, Santos, and Abreu (2019) find that the single shot detector (SSD) is an innovative mechanism in medical image analysis to identify multiple objects existing in the image through multi-box. Uphold SSD as a significantly faster machine with a high-level accuracy algorithm to detect sorts of objects delivering real-time performance. The algorithms of DL SSD match densely aligned anchor boxes by having the coordinates and predictions suitably. SSD uses pre-aligned anchor boxes to detect objects and aspect ratios. The anchor boxes comprise feature maps with a minimum of 0.8 pixels and have varied predictive models like 0.008, 0.016, 0.032, 0.064, 0.115, and 0.2. Thus, with effective detection owing to SSD, especially for cancer detection, doctors and oncologists can carve out an effective path to treat the disease [28]. Figure 2 shows the SSD architecture to identify the accurate image.

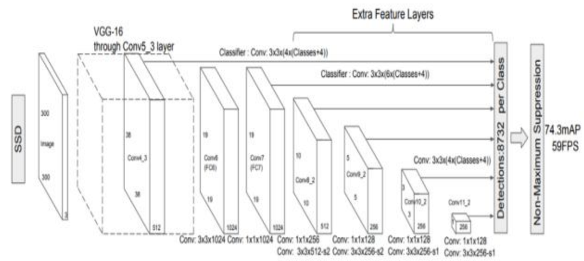

Figure 2: SSD architecture to identify the accurate image

VI. Challenges in implementing DL in cancer diagnosis and treatment

Yoo, Gujrathi, Haider, and Khalvati (2019) presented that there may be inconsistency in the images derived through medical image analysis causing trouble in suitable diagnosis and effective cancer treatment. DL is complicated mechanism and personnel without training and knowledge can end up with the wrong analysis and treatment of the patient which may be fatal. It has been perceived that CV becomes ineffective as the computer hardware limits its extent. The matter can be resolved owing to better implementation of visual programming, deployment management, and integrated device management among others [29].

VII. Methodology and Experimentation:

This section will show the mechanism to conduct the research on the implementation of the SSD Algorithm in the detection and treatment of cancer and extract a suitable outcome.

VIII. Research design

Research design presents the effective mode that the research will undertake to run an efficient study to extract the research outcome adequately. The study will consider the experimental research design to conduct an experiment to see how a variable, say DL impacts another variable in the detection and treatment of cancer. The researcher will consider DL and cancer treatment as two variables to develop a relationship between the two.

IX. Prospective validation data

The researcher will undertake around 509 macroscopic images of 381 cancer patients for object analysis. Out of those about 90% of the images will be used for training and the rest 10% for testing. The images will be in JPG format and the researcher will choose around 57 images from 48 patients for the study.

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X. Computational requirements

The researcher will take the help of an Intel Core i7 CPU that has 16GB RAM and 6GB VRAM among others. The image will be captured using RFB-SSD, YOLO-V4, VGG16-SSD, and Faster RCNN. The Receptive Field Block-Single Shot Multi-box Detector (RFB-SSD) will be used alongside VGG16 to enhance the precision of the image for suitable object detection. It will help to throw light on the mechanism of SSD to identify cancer in the human body and strives for its effective treatment.

XI. Research Findings and Analysis

The object detection algorithm of SSD facilitates detecting cancer in the human body and proper diagnosis leads to effective treatment and ultimate cure. The high resolution of SSD against other conventional formats to identify the disease rightly and the proper timing helps to curb cancer from its origin. Table 1 represents the features of SSD alongside others.

Table 1: Features of SSD alongside others

Pixels	Features
SDD300	59 FPS with mAP 74.3%
SSD500	22 FPS with mAP 76.9%
Faster R-CNN	7 FPS with mAP 73.2%
YOLO	45 FPS with mAP 63.4%

Figure 3 represents the SSD vis-à-vis other technologies.

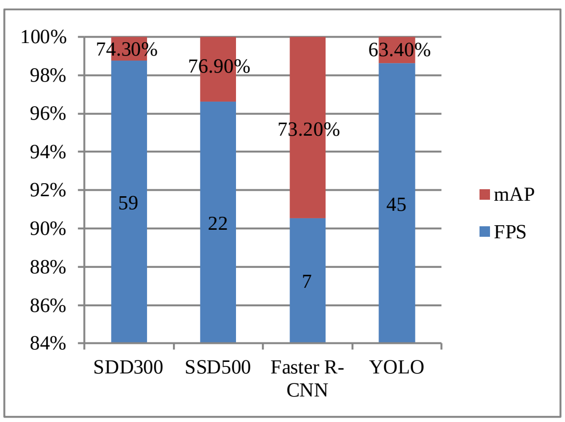

Figure 3: SSD vis-à-vis other technologies

Table 2: Specified object detection algorithms

Model	Features extraction network	Object detection	mAP	LAMR	F1	Precision	Recall
MobileNet-SSD	MobileNet	SSD	85.73%	$2.6*10^{-1}$	0.76	93.55%	64.44%
VGG16-SSD	VGG16	SSD	77.99%	$3.5*10^{-1}$	0.74	77.78%	70.00%
YOLO-V3	Darknet53	YOLO-V3	74.90%	$3.1*10^{-1}$	0.75	100.00%	60.00%
YOLO-V4	CSPDarknet53	YOLO-V4	85.36%	$2.4*10^{-1}$	0.88	97.22%	79.55%
YOLO-V4-tiny	CSPDarknet53	YOLO-V4-tiny	81.00%	$2.9*10^{-1}$	0.75	100.00%	60.00%
RFB-SSD	VGG-RFB	SSD	96.36%	$2.9*10^{-6}$	0.90	90.00%	90.00%
Retinanet	ResNet50	Retinanet	89.28%	$2.9*10^{-3}$	0.86	81.82%	90.00%
M2det	VGG16	M2det	71.54%	$3.0*10^{-1}$	0.82	100.00%	70.00%
CenterNet	ResNet50	CenterNet	73.47%	$3.6*10^{-1}$	0.63	95.45%	46.67%
EfficientDet D0	EfficientNetD0	EfficientDet	94.08%	$1.2*10^{-1}$	0.85	90.00%	80.00%
EfficientDet D1	EfficientNetD1	EfficientDet	94.34%	$1.2*10^{-1}$	0.86	90.24%	82.22%
Faster RCNN	ResNet50	Faster RCNN	88.18%	$2.1*10^{-1}$	0.72	60.00%	90.00%

Table 2 above shows the result of 12 specified object detection algorithms. The model of RFB-SSD shows the highest mAP ranging to 96.36% with the lowest LAMR of 0.00001. The findings reveal 90% accuracy alongside a 90% recall value. Thus RFB-SSD will be preferred over others to conduct the experimentation to have the highest accuracy level. The mean mAP is derived as 89.89% while the LAMR is at 0.16. Again, at the level of 0.5, the accuracy stood at 88.21% while the recall value is 88.37%. Figure 4 shows the Accuracy level of RFB-SSD for the detection of the disease.

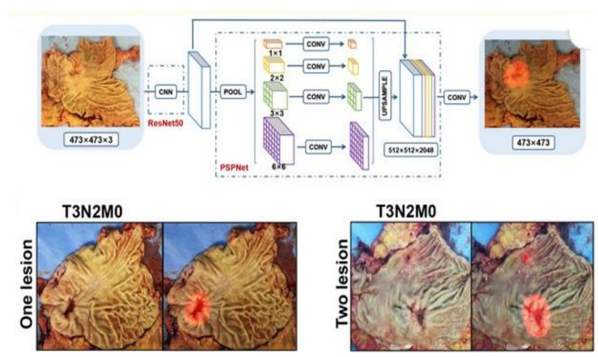

Figure 4: Accuracy level of RFB-SSD for the detection of the disease

The image shows the accuracy level of RFB-SSD in detecting the disease with its high level of precision. The predictive area has been marked in red for proper identification enabling the oncologists to understand the intensity and conduct the treatment accordingly. But oncologists across the spectrum believe that DL is a complicated aspect and proper interpretation of the image depends on the analysts or researcher. The images are fairly subjective and this may lead to distortions and inconsistencies in deriving prognostic opinions. Table 3 represents the approximate cost of training in medical imaging.

Proper clinical training to exploit such technologies in deriving a suitable result, the researcher admits that there is a lack of training and experience among the personnel involved in the process as it is quite expensive to run such training. Comprehensive visual programming with cost-effective CV software may be useful in conducting the training and leveling up the process gradually to attain a greater outcome.

Table 3: Approximate cost of training in medical imaging

DL Networks	Cost of Training
110 million parameters	$ 2.5K to $ 50K
340 million parameters	$ 10K to $ 200K
1.5 billion parameters	$ 80K to $ 1.6mn

The researcher found that the manual process in the diagnosis of the sorts of diseases has given way to the implementation of DL for effective medical image analysis. A mechanism like SSD is helpful in the early detection of cancer in the human body and its effective treatment. It is because if cancer gets suitably detected and monitored, the oncologist can treat the patient accordingly. But there are challenges like lack of engagement of the personnel in the process, the complexity of DL, ambiguity in deducing the accurate matter, and so forth. The researcher feels that with time, the mechanism will further improve to provide a formidable solution to cancer. Figure 5 represents the Early identification of cancer using DL.

The study throws suitable light on the impact of DL in the early detection of diseases like cancer. The DL algorithms are quite efficient and with the help of technologies like SSD the detection and location of cancer in the definite part of the human body have become easier. This mechanism is more efficient than the erstwhile manual processing and digital tools like X-rays, mammography, computerized tomography, and digital histopathology images make the process easier. It is believed that early detection of the disease leads to suitable consultation and treatment enhancing the scope of complete curing. Though medical imaging has led to the suitable identification of cancer in the human body or knowing the kind, it is not fully-proof to have a suitable remedy. It depends on the stage of the disease and the sort of treatment and capability of the patient to endure it.

XII. CONCLUSION AND FUTURE SCOPE

The study concludes that DL has provided a new dimension in cancer research with its advanced algorithms and SSD technology. It is gradually replacing the manual processing in pathology, radiology, dermatology, and ophthalmology owing to visual-oriented patterns. The multi-layered model of DL may complicate the system but derives the best outcome in possible detection and monitoring of the matter. The SSD technology with its high-resolution pixels provides clarity to the images to understand the nature of the disease, say the stage of cancer. Subsequently, it leads to suitable treatment and clinical resolution as per the gravity of the matter. Medical image analysis has been a revolutionary aspect of pathological study leading to the early detection of deadly diseases like cancer and seeking a formidable solution with the help of experts. But there are doubts about a proper diagnosis of the matter as the person may not be adequately trained to lead to wrong treatment and dissolution of the entire exercise.

The study has undertaken the relevance of several academic literatures as secondary resources while interviewing an oncologist and a cancer researcher for primary data. The interviews could have been more intricate and diverse by including more participants. But it was not possible owing to limited resources and time for the purpose. The study should be a continuing one to highlight the development in the field of DL and present things adequately. Since it is on-going research, the researcher can update and nurture the findings with new dimensions and extract suitable research analysis and outcome.

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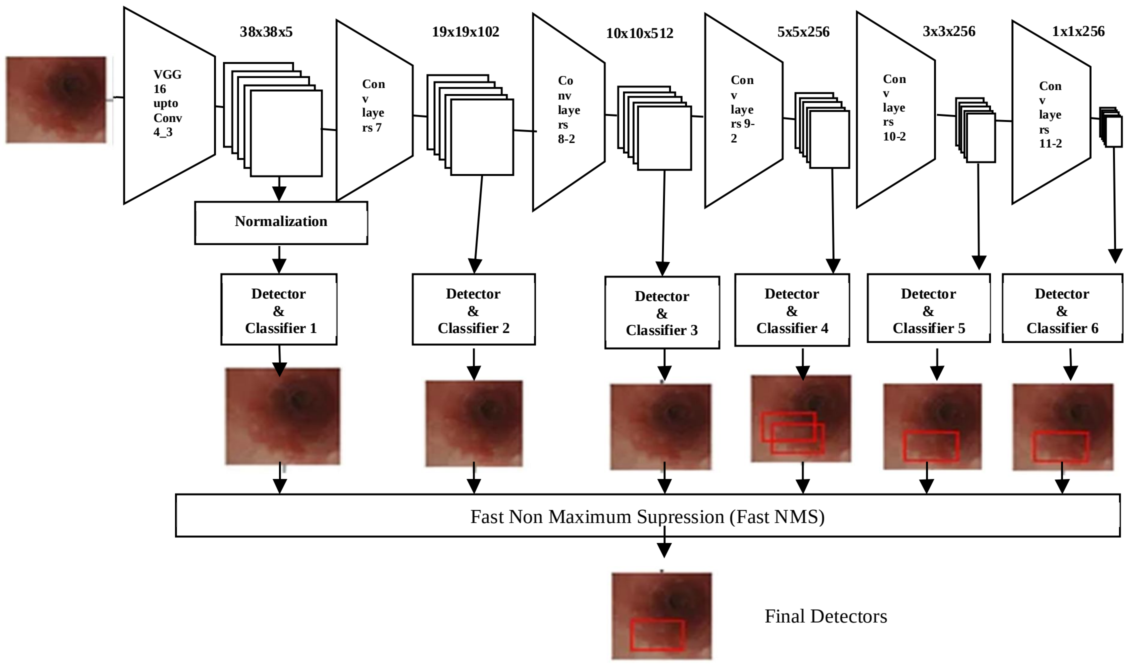

Figure 5: Early identification of cancer using DL