UNDERSTANDING AND IDENTIFY VISIONARY ELEMENTS OF A RETINA FROM RETINAL IMAGE

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This Report Presented in Partial Fulfillment of the Requirements for the Degree of Bachelor of Science in Computer Science and Engineering.

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APPROVAL

This Project/internship titled "Understanding and Identify visionary elements of a retina from retinal image", submitted by Masbah Uddin, ID No: 171-15-9303, Emtiaz Mahmud, ID No: 171-15-8877, Tanzina Afroz, ID No: 171-15-9320 to the Department of Computer Science and Engineering, Daffodil International University has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of B.Sc. in Computer Science and Engineering and approved as to its style and contents. The presentation has been held on 28th January 2021.

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DECLARATION

We hereby declare that, this project has been done by us under the supervision of **Ms. Israt Ferdous, Lecturer, Department of CSE** Daffodil International University. We also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma.

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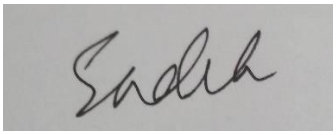

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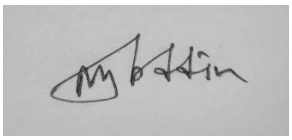

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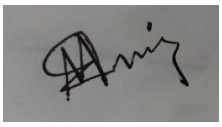

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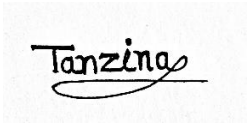

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ABSTRACT

Retina is a very important visionary element of our body. The elements of the retina are also very important and the researchers all over the world are very keen to know & identify those elements. The current improvement in our technology and computer science gives us the proper power to segment a retinal image and also identify those elements of the retina simultaneously. The power of computing more and more gives us the effectiveness to use machine learning and computer vision and use more image to train the machine and get more accurate simultaneous accurate result. There are a lot of research happened in the field of machine learning and those are quite good and also accurate but in most of the case most of them tries to identify one or two retinal elements in their research but we are proposing in our model that we can accurately identify three retinal element and with more accuracy. There are two paper which of them identify three retinal elements like us but one of them are 1999th research and the another one is 2017th and the newer one uses one CNN model to train the machine and one CNN model generating the output of those three elements so in that case every element are not quite accurate.[1][2] We are proposing a new model with three CNN model which would be identifying every element distinctly so every CNN model would be train for a single element of the retina so the resultant output would be much more accurate. We had calculated and tested that with three CNN model can provide us at least 7 to 12 percent more accuracy than a single CNN model.[1] The three element we are identify by image segmentation are optical disk, blood vessels and fovea. All the models are pre trained and tested with a same dataset which was public and available.[5][6]

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CHAPTER 1

Introduction

1.1 Introduction

Retina is a sensory part of our body it contains some feature and our model is about identify some feature of retina from retinal fundus image that would be helpful for medical sector. In the developing county which has less per capita income such as south Asian country like Bangladesh and Indian peoples have more eye sight complication then much developed counties. In a middle-income country in Latin America, the leading causes of blindness will be glaucoma and diabetic retinopathy. Because cataract surgery is more readily available, fewer people become blind from cataract. In a wealthy country, glaucoma and cataract will continue to be very common and important conditions, but most of the blindness will be due to retinal disease.[10] Retinal diseases are already the most common cause of childhood blindness worldwide.[11] In medical science the role of image processing or analyze to assist clinical decision-making has spread across a huge number of researchers. The more computing power of new edge computers are gives researchers the power to use machine learning technique to identify more about the image of the retina it would be much more then human eyes. Image segmentation is a very common procedure to identify the elements of the more and more powerful GPUs are providing the power to train more model and train the machine more accurately. We use CNN in our model to identify the retinal elements such as optical disk, blood vessels and fovea all those elements in a single research are very rare and getting more accuracy in all three elements is also very rare we use multiple CNN to get more accuracy in all those three elements. We proposed a model with three CNN so every element can have their own CNN model in which model only one model can be trained so that the resultant output of the model gets more accurate then then a single CNN based model. Our proposed model gives us that it can produce 7 to 12 percent accuracy increase in some fields we are generally trying to test a single dataset in every pre trained model so that the comparing process stay equal. So, we used DRIVE dataset which is free and a public dataset.[5] To test some well-known model in the field of image processing we generally search a lot of models which we can use to get more accurate result we find HED model and the accuracy level of the model was quite impressive.[3] though all these models are per trained so we can't tell that how much trained they are but we used

highly trained model to get rid of any kind of overfitting issues. We choose to work with image processing and also choose to work in the field of medical imaging because we think that medical imaging is a huge sector which have a huge scope where we can help with the power of newly formed algorithms of AI & Machine Learning. With the help of powerful computing and new and advance algorithms we can help the medical sector tremendously. With the feature we identified in this research we can farther used those data in the sector of medical computing such as Diabetic Retinography or DR which is a very common research aria of computer engineers. Our research will help future engineers to do their research with more precision and accuracy.

1.2 Motivation

The main motivation behind of this research we want to create a proper model with the high accuracy and precision which can identify and also segment the key three features of the retina in a single research which is very rare as we previously said that we only find two research paper that identify those three key features of the retina which is blood vessels, optic disk & fovea. Our main intention is with this research project is we wanted to develop a model that can help future researchers and the user of the medical imaging sectors such as doctors and medical student can take the benefit of the modern computing algorithms which can provide a higher accuracy. The future researchers who want to work with retina and retinal segmentation can use our model to get the comparison purpose and future development purpose. The future of medical imaging is growing day by day diabetic retinography or DR is a very common field of research among a lot of engineers and scientist we know that in a DR the retinal image consist a lot of spot in the retinal image though we are identifying fovea in our model which is a kind of spot in the retinal image so in some case a researchers find a multiple spot like fovea it can think about DR and do there farther prosses to identify the case like that there are a lots of field where those segmented and identified image can help to the researchers and medical sector.

1.3 Rationale of the Study

AI or Artificial Intelligence is a Significant part of computer science and machine learning is also a major sub domain of that and also image processing. We are using a most common ai algorithm in our model which in CNN. CNN is a commonly known AI algorithm and its application and implementation is huge in our current domain of AI. It can produce some

extraordinary result with a larger number of accuracy rate in taring phase of a machine learning sector that's why it is very often use in now a day in modern AI based work. In our proposed model we used not only one CNN model we used three CNN model of identifying and detecting of three individual elements of a retina. This prosses can be little bit complex then a single CNN based work in the same related sector but it can provide us lot more accuracy than a single CNN based work which is shown in our paper and report. Rationality of the study is that we are using a very powerful and well tested algorithm more than one to get a more accurate and stable result in any dataset which have a fundus image.

1.4 Research Questions

The main and fundamental question about our research is how we are going to identify all three of the retinal elements with more accuracy?

How is our model architecture going to look like is another question?

How we would preprocess our data it is another question?

How much complex those models would be it is another question?

What we would do to reduce over fitting is another question?

1.5 Expected Output

In our proposed model we are expecting all three-key element of the retina which is optical disk, blood vessels and fovea with a good accuracy rate which is 82% for blood vessels, 97% for optical disk and 88.5% for fovea.

The required accuracy rate we can get from using the dataset DRIVE which is a free and open dataset.[5] This is a well-known dataset and highly used in the retinal imaging sector. The accuracy we are targeting we can find that from DRUI which we used for blood vessels and optical disk.[4] For the fovea we are also using the "Segmentation of optic disc, fovea and retinal vasculature using a single convolutional neural network".[1]

1.6 Report Layout

Chapter 1: There is introduction, objective and expected outcome of the project work we have done is written here and the report layout.

Chapter 2: This is about background. This chapter is all about the background situation of our work that we have done.

Chapter 3: There is our research methodology. Data collection procedure, data pre-processing, data analysis, about our model, model structure and model architecture also have been discussed there.

Chapter 4: There are experimental results and discussion.

Chapter 5: There is impact on society and we also discussed about the ethical aspects.

Chapter 6: There is summary, conclusion and implication for future research future work has been discussed there also.

CHAPTER 2

Background

2.1 Introduction

The terminologies we used for our research are all very commonly used terminologies they are given bellow:

- Research model
- Data set
- Sample
- Abstract
- Assumption
- Hypothesis
- Assumption
- Population
- Limitation
- Construct
- Concept

2.2 Related Works

Retinal image identification and segmentation is a very commonly used area of image possessing sector and we find a lot of research in that area we also see and take some inspiration from that. The first part of our research was finding the related work and what happed till now and what are the area which are still not completely explored and we find some interesting data and fact that we can work with.

We find those research work in a lot of will reputed journals and conferences and google scholar. We generally find the related research in various journals such as Elseviers journals, springers journals, IEEEs journals and also in google scholar.

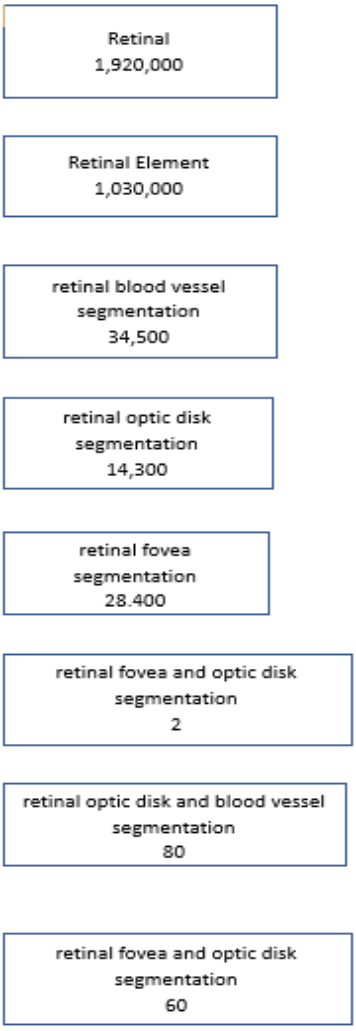


Figure 2.1: Related research work.

2.3 Comparative Analysis and Summary

The three thing we are going to identify or generate in our research are only find outed by only two research which is given in the following figure 2. As we can see that there are a lot of research which identify one or two elements of the retina so our model going to be very competitive and unique. So, we are hoping that a good and competitive study and research we are going to provide.

2.4 Scope of the Problem

Medical imaging is a huge field in image processing sector of machine learning. In medical imaging the x-ray image or fundus image is highly used in image processing sector and a lot of 3D modeling if body organ is also very popular and useful in health sector. Retina or eye related image

is very easy to collect and they are easily transferable to a machine and those visible images are easily detectable and they can be found in a dataset with a high quality.

The lot of eye related problem can be identified by the machine with a higher accuracy rate and the accuracy generally is more than human eye.[4] that's why retinal image processing, image segmentation, image identification is grate scope for the future researchers. Diabetic Retinography (DR) is a great future scope for future researchers which can be nicely implemented by this image segmentation process.

2.5 Challenges

The main challenges of this type of research work are availability of a huge dataset for training the model. If we use a less amount of data to train our model then it could face some offer fitting issues. So, for handling this type of scenario we need to work with a large of dataset and getting those fundus images can be hard. So, we used pretrained model which has used a significantly large dataset to train their model then we used a single dataset with nearly 500 images and then test those models with that single dataset. Data preprocessing is another challenge in the sector of image processing but in our proposed model we used unprocessed image but in "Segmentation of optic disc, fovea and retinal vasculature using a single convolutional neural network" they used normalization for train their model.[1]

CHAPTER 3

Research Methodology

3.1 Introduction

Retinal diseases are already the most common cause of childhood blindness worldwide.[11] In medical science the role of image processing or analyze to assist clinical decision-making has spread across a huge number of researchers. The more computing power of new edge computers are gives researchers the power to use machine learning technique to identify more about the image of the retina it would be much more then human eyes. Machine learning is a very commonly used and well reputed field of research interest and computer vision is also one of the major sub field of that. It is not only about interest it is also a play a vital role in predicting and identifying the elements of a lot of image processing sector and one of this is retinal image identification. Though our research is a model-based research we used a lot of pre tried model which is used machine learning and also used the most used and most accurate algorithm which is CNN.[9] Now a days Faster R-CNN is also a very useful and gives more fixability to work with but we know that it can be more complex and need more computing power then a CNN based model.[7][8] We choose to work with the CNN based model and it can also generate a higher accuracy rate and precision. [4][1][3]

3.2 Research Subject and Instrumentation

The subject of our research is "UNDERSTANDING AND IDENTIFY VISIONARY ELEMENTS OF A RETINA FROM RETINAL IMAGE" and the aim of our model is making a unique model which has a higher accuracy rate than the current ones. We used lots of open-source dataset such as DRIVE & STARE.[5][13] Those datasets were fresh dataset of a fully healthy condition of a retina on the other hand we also used DIRiD dataset which is not all fresh and clean fundus image of a healthy retina. In that DIRiD dataset there are a lot of image that are affected by a diabetic retinography.[12]

We used multiple CNN to get more accurate result it's can generate more accuracy than a single CNN model-based model. Which is the main goal of our model to get all three retinal elements in a single model with a higher accuracy rate.

3.3 Data Collection Procedure

Data collection is not a very difficult part of our research project because we used the fundus image of a retina to test our model. Though our model was pre-trained model so we don't need that much data to re-train the model, we just need the test data which can check the model accuracy and generates the result.

We used three open-source dataset of the fundus retinal image which are

- DRIVE [5]
- STARE [13]
- DIRiD [12]

The total image samples of those three datasets were nearly 900 fundus image of a healthy eye fundus image and also the DIRiD dataset have the image with eye related problem such as DR or diabetic retinography.

3.4 Implementation Requirement

3.4.1 Model requirements

We need to use Caffe model to execute the model of DRIU and also HED model which has a very appreciable result according to the result.[3][4]

Caffe model is a machine learning model which is created and developed by Berkeley Vision and it has some requirements and dependencies both fully and partial.

The requirements and dependencies are (for Windows system):

Requirements

- Visual Studio 2013 or 2015
    - Technically only the VS C/C++ compiler is required (cl.exe)
- CMake 3.4 or higher (Visual Studio and Ninja generators are supported)

Optional Dependencies

- Python for the pycaffe interface. Anaconda Python 2.7 or 3.5 x64 (or Miniconda)
- Matlab for the matcaffe interface.
- CUDA 7.5 or 8.0 (use CUDA 8 if using Visual Studio 2015)
- cuDNN v5

NB* you can find all the necessary instruction and requirements in https://github.com/BVLC/caffe/tree/windows here or https://caffe.berkeleyvision.org/ here.

3.4.2 Dataset requirements

The second thing we need our model is fundus image of the retina and that fundus image (figure 3.1) is a special type of image that generally used in the hospital by the doctors and technician and that type of image is very accurate and segmenting with that image is generates a higher accuracy rate.

Figure 3.1: retinal fundus image

Fundus image can be found in a lot of opensource image dataset and also can be collected from an eye hospital which generally use that canon cr-2 plus af digital non-mydriatic retinal camera but the main problem with the hospital image is that the image sample from the hospital-based fundus image is with lot of complications that so though it is a supervised model and we used a trained model we choose the open-source database image not the hospital generates images.

In figure 3.2 that is a canon cr-2 plus af digital non-mydriatic retinal camera which is the system that can generates the very high-quality fundus image.

Figure 3.2: canon cr-2 plus af digital non-mydriatic retinal camera. [Canon USA]

3.4.3 Indicating the Pre-processing Steps of Research Procedure

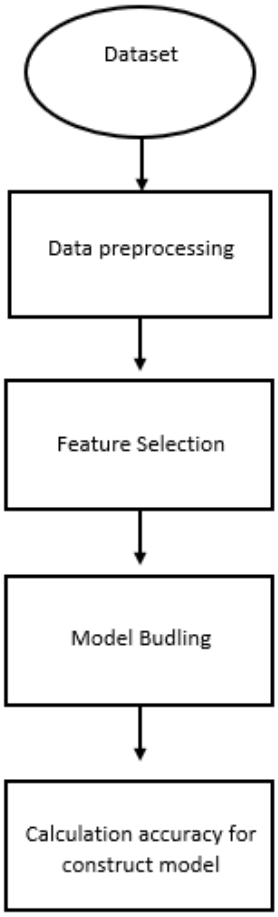


Figure 3.3: Stages of Working Procedure

3.4.4 Data Pre-processing

Dataset pre-processing is one of the major tasks of a research-based project. Though in our model we used two pretrained model that why we don't need to pre-process the data we can easily took any retinal fundus image dataset and test them with both two of our pre-trained models. One of the models used DRIVE dataset to train the model and also STARE dataset to train and then test with the corresponding dataset and also with some other dataset.[4] On the other hand the second CNN model we used to test our dataset that used one single image pre-possessing methods which is normalization of the data.[1]

3.4.4.1 Normalization

They normalized the colour image before they played out any classification (Figure 3.4). They used the techniques laid out in the Section 3.A (official manuscript)/Section 3.1 (uploaded manuscript) from [15] to do the normalization, with just one change made. They converted a fundus image from RGB colour space to LUV colour space, ran the procedures on the L channel (luminance channel), and with the adjusted L channel, they converted the image back to RGB colour space. In this case the product is a normalized colour image, which they clime has a wider use then the actual base normalization.[15][1]

Figure 3.4: Before and after the normalization.

3.5 Implementation Requirements

3.5.1 Model

A model generating is a basic and fundamental part of a research-based project. In our proposed model we propose a single model architecture which is CNN and then we use two different model to identify three different elements of a retina.

Our proposed model can identify the three elements of a retina which are shown in the figure 3.5. We are proposing a single CNN model architecture for blood vessels and optical disk.[4] and another CNN model architecture for fovea identification.[1]

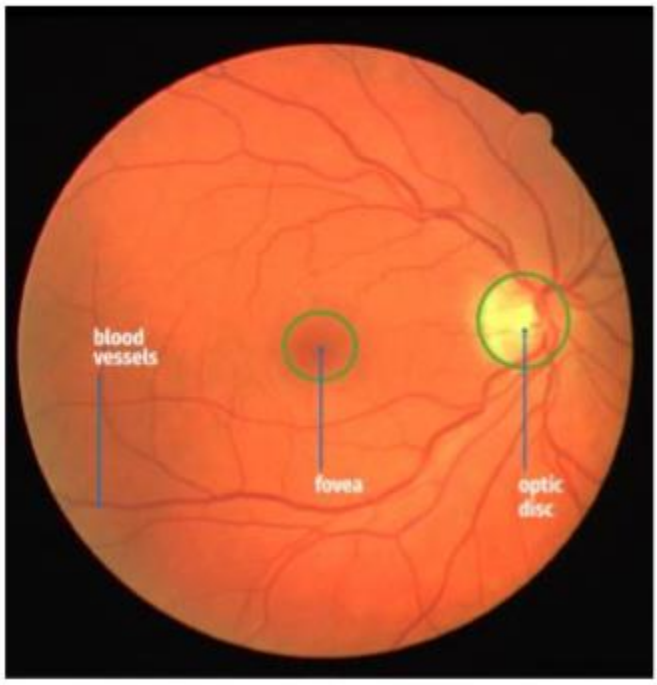


Figure 3.5: Identifying element of a retina in our model.

3.5.1.1 Model Type

As we know that an AI learning model can be supervised, unsupervised, semi-supervised or reinforced based on the feedback characteristics. The models we used in our proposed model both are a supervised learning model. A supervised learning model can perform more batter than an unsupervised learning model for blood vessels identification.[14]

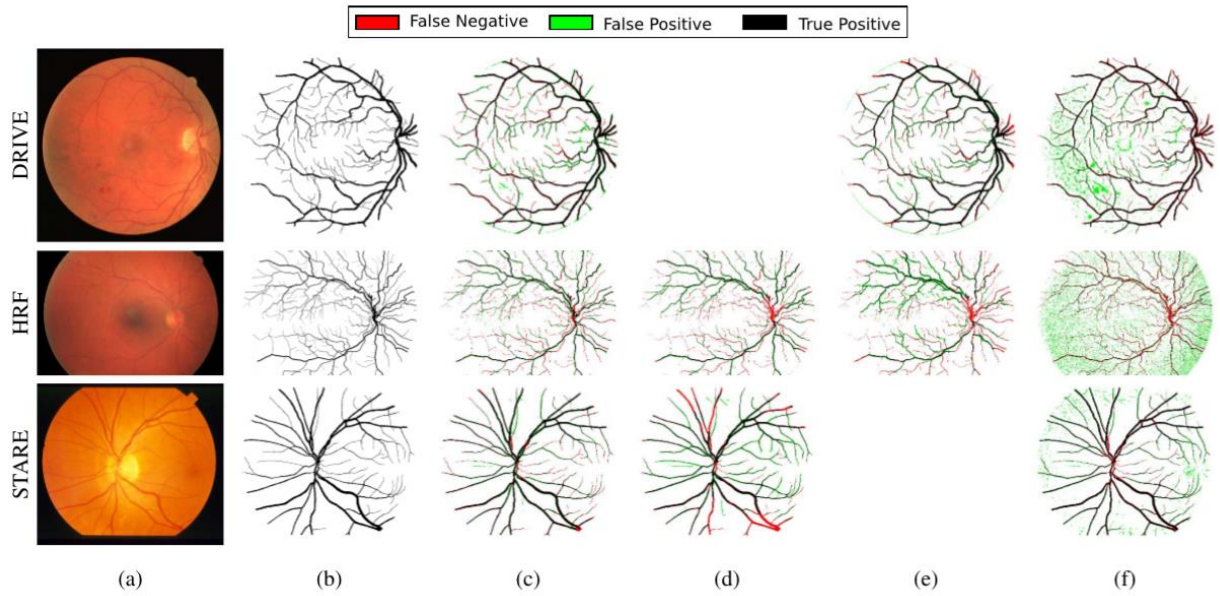


Figure 3.6: supervised and unsupervised learning model accuracy comparison for blood vessels identification.

In figure 8 we can learn about a detailed compression about a supervised and an unsupervised learning model. Where (d) & (e) is a part of (b).[4] (c) is also a supervised learning model.[14] On the other hand (f) is an unsupervised learning model.[16]

Here we can see that a both supervised learning model (b)&(c) done a good job over an unsupervised learning model (f) on a retinal blood vessels segmentation.[14]

3.5.1.2 Model Details

The fundamental principal of our proposed model is based on a convolutional neural network (CNN) but beside using a traditional CNN architecture we are using two CNN models for detecting three retinal elements those are optic disk, blood vessels and fovea. One model will identify and segment only fovea and on the other hand another model will identify other two retinal elements which is blood vessels and optical disk.

Though we are using a pre-trained model for our proposed model that's why the model architecture will be similar to the original one.[1][4]

Model 1 is the model which will segment and generate the optical disk and also the blood vessels. That model is using an entropy loss function which was originally proposed in [3] for the task of

contour detection in natural images. The model was adopted the concept of HED and implemented in their model.

the equation is initially developed by [3] and then it is modified and implemented in the retinal imagining sector by [4] and here they denoted testing dataset as S = {(Xn,Yn),n=1,...,N}, with Xn being the input image and Yn = {y(n) j ,j =1,...,|Xn|},y(n) j ∈{ 0,1} the predicted pixel-wise labels. The loss function is defined by the equation 1.

$$\mathcal{L}(W) = -\beta \sum_{J \in Y_+} P\left(y_j = 1 \left| X; W\right.\right) - (1-\beta) \sum_{J \in Y_-} P\left(y_j = 0 \left| X; W\right.\right) \qquad (1)$$

W is denoted as the slandered parameter of the CNN architecture. They used β which is a multiplayer which generally handles the imbalance of the substantially greater number of backgrounds compared to foreground pixels.[4]

For model 2 we also used a pre-trained model which is [2] and the mathematical equation they used to update the weight is

$$W^l = \left(1 - \frac{\eta\lambda}{\varphi}\right) W^{l-1} - \frac{\eta}{k} \frac{\delta c}{\delta W} \qquad (2)$$

Where *l* is the layer number, η is the learning rate of the model, φ is the total number of the training samples, λ is the parameter for regularization, *k* is the batch function and lasty c is the cost function.

And finally, the Biases are update by the following equation

$$b^l = b^{l-1} - \frac{\eta}{k} \frac{\delta c}{\delta b} \qquad (3)$$

Where b is the biasing factor.[1]

3.5.1.3 Model Architecture

Though we didn't train our model so we used the same model architecture of the following model [1] & [4].

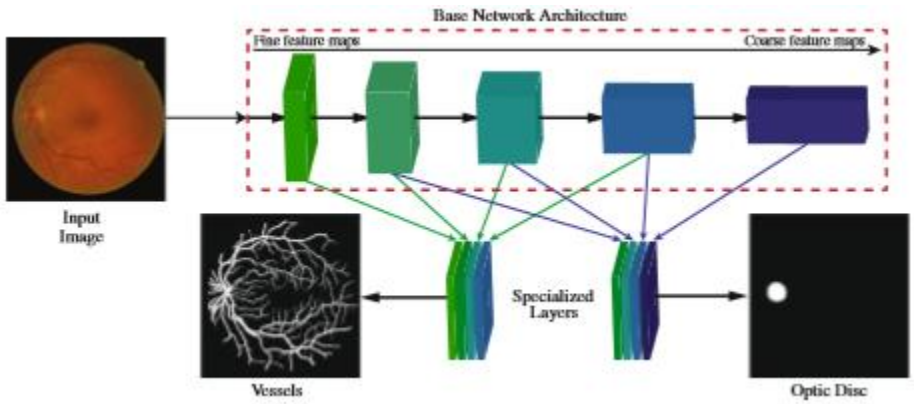


Figure 3.7: model 1 architecture.

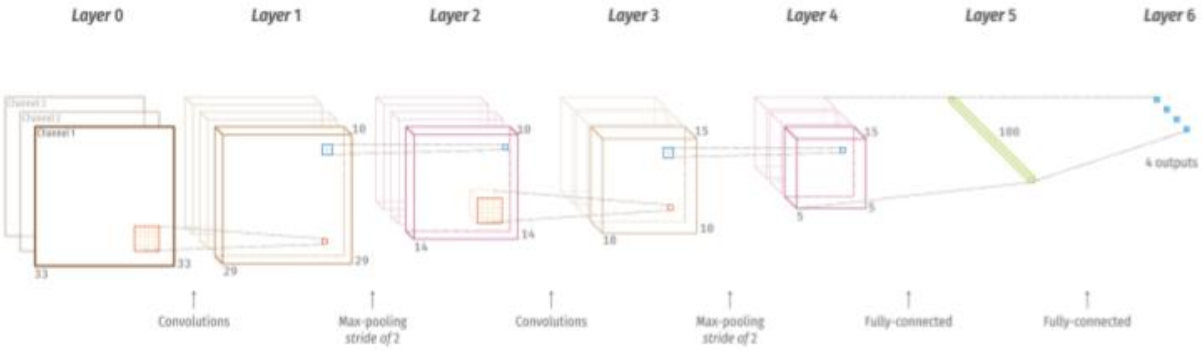


Figure 3.8: model 2 architecture.[1]

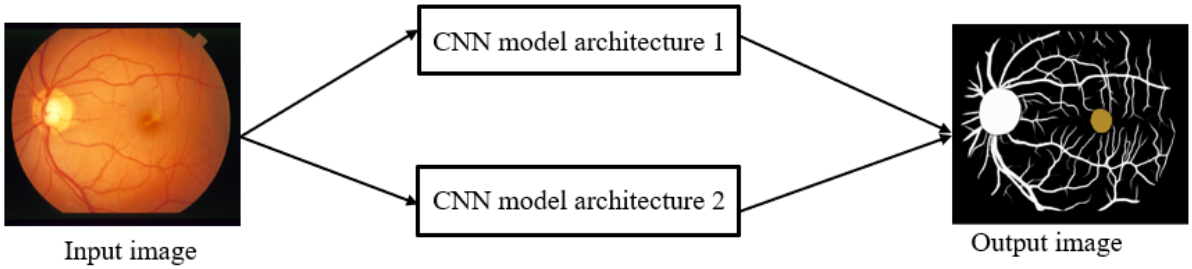


Figure 3.9: Our proposed model architecture.

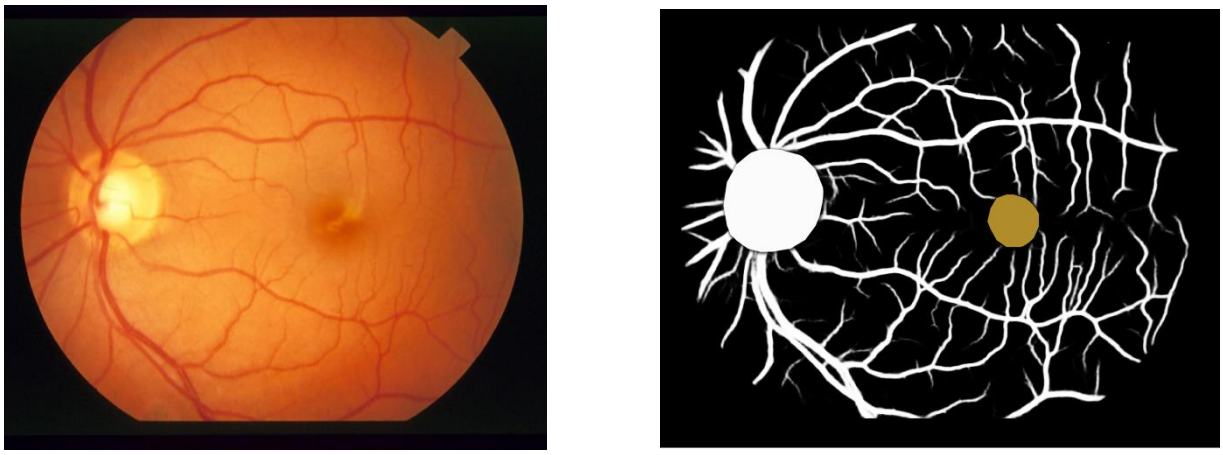
Our proposed model main goal is two combine two CNN model which has a higher accuracy and also can segment all three retinal element blood vessels, optical disk and also fovea. By using our proposed model, we can identify all three retinal elements with a higher accuracy rate and also with more precision.

CHAPTER 4

Experimental Results and Discussion

4.1 Experimental Results & Analysis

The result of our project is very simple it's generally generates an output image with the segmented features of the given input image in this case it's generates an output image with all three element of the retinal image we are aiming for.



Input image Output image

Figure 4.1: Proposed resultant image

In the resultant output we got all three retinal element we were trying to achieve for that we used two CNN model in our proposed model and we got some significant accuracy in that.

The best accuracy of the first model which is identifies only optical disk and blood vessels are 95.9% and 83.1% for those two elements.[4]

The overall accuracy of the second model is 93%.[1] But in that overall accuracy they calculate the average number of all the three elements not the single elements of that retinal element. The accuracy the found for single element are given in table 1.[1]

Table 4.1: Tan et al. sensitive and specificity data analysis.

	Sensitivity	Specificity
Blood vessels	0.7537	0.9694
Fovea	0.8853	0.9914
Optic disc	0.8790	0.9927

Table 4.2: our combined CNN proposed accuracy.

	Blood vessels	Fovea	Optic Disk
Tan et al. [1]	0.85	0.93	0.93
DRIU [4]	0.831	-	0.959
Our	**0.831**	**0.93**	**0.959**

The part-by-part accuracy was not given in that paper but by seeing there sensitive and specific data we are assuming that the accuracy would be nearly 85% for blood vessels and 93% for fovea and finally 93% for optic disk.

But applying our 2 CNN based model we are expecting an 83.1% for blood vessels, 93% for fovea and 95.9% for optic disk.

Though the optic disk accuracy would be nearly 3% higher than the tan et al. accuracy the overall accuracy would be higher than that 93%.[1]

In the following figure 4.2 that was the resultant image of Tan et al. [1] which used one CNN based model to identify all three elements of a retina which we also trying to identify.

In the following figure 4.3 we are expecting that output with a dual CNN based model. And we are expecting that it would be much complex then single CNN based model but we are getting a much higher accuracy.

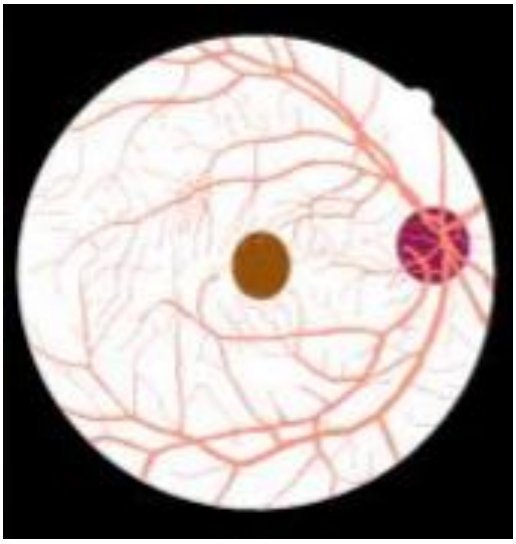


Figure 4.2: Tan et al. output image.

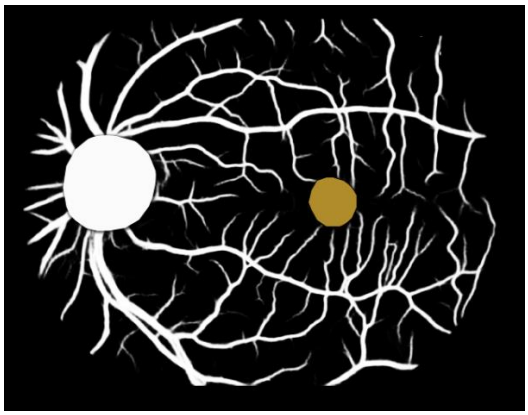


Figure 4.3: Our proposed model output image.

We are expecting a high-end retinal features identification and segmentation which also has a high-end accuracy and which can be achieved by the use of multiple CNN based architecture.

4.2 Discussion

Model 1 we used to identify the blood vessels and optic disk used near about 500 image data to train their model and we used their trained model. After seeing 500 images to train a model the first question arises that the accuracy it shows that can be overfitted accuracy but in that case the scientist used 20000 iterations to train the model it is huge and after that many numbers of iteration there can't be any overfitting issue.[4]

We can have tried to train our model but to get that much accuracy we need to iterate that much time but that is not compatible with the normal computer we use now as a student.

In our proposed model we could have try to train those models once again and then test the selected data to generate accuracy but the complexity and the required processing power needed for that is beyond our reach. As we said that model 1 used 20000 iteration on 500 image data and they used a very powerful NVIDIA TITAN-X GPUS.[4] On the other had the second model we used that model used 125000 image sample to train their data and they used a workstation server with 2.4GHz processor with a memory of 512GB.[1]

The memory size or the GPU power is quit un reachable for an undergraduate student like us that's why we used the pretrained model to calculate the accuracy.

So, we are aiming that with our proposed model we will be able to get all three-fundamental element of a retina image and also with a good accuracy rate.

CHAPTER 5

Impact on Society

5.1 Impact on Society

Historically, retinal disease always had a low priority in prevention of blindness in developing countries such as Bangladesh, India and may other south Asian country. There are several reasons for this. Firstly, it was thought that retinal disease was an uncommon cause of blindness in the developing world; secondly, that the results of treating retinal disease did not justify the effort and expense involved; and, thirdly, that the equipment required was too costly and unreliable for use in a developing country environment. Finally, there is a lack of skilled personnel with sub-specialty training in retinal disease.[10]

There are many kinds of retina related diseases in the world and many of them can causes blindness in ultimate case or scenario. For preventing or determining those retina related problems we need to determine retinal defect as early as possible so that it could be prevented or cured. We all know that machine learning and image processing is having the best time because of the available higher computing power and some state-of-the-art algorithm such as CNN, RCNN & HED.[8][3] those can help to identify any defect or misbehave and that's how the disease identification could be very fast and cost effective.

The impact of our model in the society would be it could help the manufacturer of the retinal equipment's and also with the future researchers and also well as medical student and enthusiastic to learn and visualize more about the retina beyond our visualization capabilities.

5.2 Ethical Aspects

In every scenario of our life, we need to think about the ethics. A research can be very unique or outstanding but if it has not any ethical value that makes the research ineffective, we need to think about the ethical aspect of anything before we create or generate something. The ethical aspects of our following model are it can be very much useful for mankind and it can prevent a lot of unnecessary blindness in the near future. There are some computer ethics we followed for the research.

We didn’t use a computer to harm other people.

We didn’t interfere with other people’s computer work.

We didn’t snoop around in other people’s computer files.

We didn’t use a computer to steel.

We didn’t copy or use propriety software for which we haven’t paid.

CHAPTER 6

Summary, Conclusion and Implication for Future Research

6.1 Summary of the Study

In the initial part of our study, we try to identify the aria of work around retina and then we try to understand what are the elements of a retina what they do in our visionary system and how they can be damaged and how to identify the damaged one. Soon we get to know that there are a lot of study going on in the subset of retinal image segmentation in that most of the time the researcher tries to identify one or two element of the retinal feature and most of the case blood vessels and optic disk but fovea is also a very important part of a retina and the study over segmenting a fovea on retinal image is in a significantly low in number you can see that in figure 2. All the three major element of a retina which is blood vessels, optic disk and fovea identification or segmentation is very rare such as we only can find two research paper which identify or segmented all the three elements which is [1][2]. [2] is a paper of 1999 when high computing power is a bit of problem so the paper we actually counted is [1] which is a more recent work on retina and they done a quit a good job but they used a single CNN model to identify and segment all the three elements of that retinal image but we are proposing a model with 2 layer of CNN and we are expecting a higher accuracy rate then [1]. In our proposed model we have shown that a higher accuracy can be achievable by using a two CNN model for identifying different elements of a retina.

So, in our proposed model we used 2 different model which is from [1] and [4]. Both models are well tested such as in model DRIU [2] the compare their blood vessels segmentation output with some current state of the art models such as [17][18][19]. Also, they tested and compare their model with some traditional model such as a line detector which is an unsupervised learning model also [20][21]. The resultant output they got over those well-known models is very impressive.

In our propose model we showed that our double CNN based retinal image segmentation can achieve a significantly high number of accuracies in which all three elements will get a respectful accuracy not only one or two. The accuracy can be achievable with our proposed model is 83.1% for blood vessels, 93% for fovea and 95.9% for optic disk.

We are hoping that the result we are able to achieve can create a huge impact in the retinal image segmentation sector and also it will be very much implementable in the future research area which has a same field of retinal image segmentation.

6.2 Conclusion

Now a days, machine plays a key role in many health-related realms such as the development of new medical procedures or creating a new equipment for medical diagnosis etc. An intelligent machine can be a new way of medical diagnosis. Medical imaging is also very key interest of new age researchers. We all know that due to the current shift of modern computing the computing power of a day-to-day computer is very high and the current GPUs are also providing us the proper power to build a new machine learning algorithm such as CNN, R-CNN and also lots of others algorithm and those algorithms provide us the power to increase the efficiency and accuracy of the medical equipment's. Our proposed model would be the first step in that direction. It can find all the three key components of a retinal image and with a significantly high amount of accuracy. That can also provide the scope to the future researchers implement and modify that for a higher number of accuracy or more efficiency. We are hoping that in near future lot of researcher would want to work with all three element of retinal image and they will gain a significant increment in efficiency.

6.3 Implication for Further Study

The aria or field of the topic has a very wide aria of implication. Now a days, there are lots of new algorithms are coming out and those new algorithms can help to gain the accuracy level farther more than us. The new state of the art algorithm can be bit complex to work with but in some case, they can gain significant results. For future studies researchers can use R-CNN model that can help them to get outstanding result.[8] The field of medical imaging is full of opportunities not only for the retinal imaging but also for other organs imaging sector. In the field of retinal imaging DR or diabetic retinography is a very popular aria in that sector generally researcher compare a healthy retinal feature with an infected retinal feature and in that case our proposed model can help significantly because it will give them all the features of a healthy retina with some extraordinary result and they can compare them and use that in there required model.

So, we are hoping that our proposed model would be a great resource for the future researchers to compare, improvise or implement their own future models. It has some opportunities and features for being used in the further study cases.

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