Project Report (August 15, 2021)

Ankita Ghosh[1] **and Sahil Khose**[2]

[1]Research Assistant, ghoshankita0907@gmail.com , CSE, MIT Manipal
[2]Research Assistant, sahilkhose18@gmail.com, ICT, MIT Manipal

ABSTRACT

We discuss the following in our report - new segmentation pipeline, new loss function, grid search, pre-processing, semi-supervised learning. We are very content with the progress that we have made since our last report.

New Segmentation pipeline

- We have undergone **major changes** in our segmentation pipeline, especially with respect to the **metric calculations**.
- We hypothesized that the metric formulas used in non-DL papers and DL papers for this medical application are considering only the **fovea** segmentation and the DL framework being a **binary** segmentation task should also map the formulas to a **single channel metric** instead of the **double channel metric** which is the agreed upon **convention** the DL tasks.
- Hence we update all of our results after **building and fine tuning** the new segmentaion pipeline.

New Loss functions

- We also added the **Twersky Loss** as a weighted loss for our final loss along with BCE Loss. We found that this converges the models to obtain a considerable improvement in our results.
- We fine tune the weights for the final loss formula through a grid search method, resulting in best weights to be **0.7 for Twersky and 0.5 for BCE and 1.5 for Gamma.**

Algorithm 1: Semi-supervised classification train loop

Input: Sample image
Output: Class of the given image

for $epoch \leftarrow 0$ **to** E **do**
  if $epoch < E_i^\alpha$ **then**
    $\alpha \leftarrow \alpha_i$
  else if $epoch < E_f^\alpha$ **then**
    $\alpha \leftarrow \frac{\alpha_f - \alpha_i}{E_f^\alpha - E_i^\alpha} * (epoch - E_i^\alpha) + \alpha_i$
  else
    $\alpha \leftarrow \alpha_f$
  end if
  Run the model on train set
  $loss \leftarrow BCE(l, \hat{l}) + \alpha * BCE(u_{epoch}, u_{epoch-1})$
  Generate the pseudo labels for unlabeled data
  Evaluate the model on validation set
end for

Figure 1. Semi-supervised Algorithm

Grid Search

- We run a logarithmic grid search method for our Learning rate and find the best LR to be **5e-4**
- After the refactoring of the entire pipeline for the new metrics, for finetuning the new pipeline we **trained over 30 models** till convergence to find the best possible LR and loss weights for our final loss.

Pre-processing

- We also added **cropping** to increase the number of datapoints and added a pre-processing technique - **inverse histogram equalization** to obtain improvements in our performance.

Semi-supervised Learning

- Another significant addition to our pipeline was the addition of **unlabelled Messidor data (1200 datapoints)** to the existing **labelled data (484 datapoints)** and trained it on a **semi-supervised algorithm** as shown in **Figure 1**.
- This addition is still under experimentation and is expected to leverage the unlabelled data to improve the performance further.

Fovea Segmentation

Method	Dice(F1score)	Jaccard(MIoU)	Sensitivity	Specificity	Accuracy
Traditional Method (non-DL)	0.8044	0.6881	0.8162	**0.9984**	0.996
Deep Learning (ours) 0.7 w/o pre-processing	**0.8243**	**0.7052**	**0.9174**	0.9975	0.9957
Deep Learning (ours) 0.8 w/ pre-processing	0.8134	0.6883	0.8865	0.9980	**0.9962**
Deep Learning (Tan et al)	-	-	0.8853	0.9914	-
Deep Learning (Sedai et al)	0.81	-	-	-	-

Table 1. Metrics Comparison

- Figure 2, 3, 3 show an example of a visual result by our model.
- We graph and evaluate our results based on the **metrics**: Dice, Jaccard, Sensitivity, Specificity and Accuracy.
- **Table** 1 shows a comparison between our model and the other methods based on the metrics stated above.

DL papers for fovea segmentation

1. Paper 1: Tan et al
2. Paper 2: Sedai et al

Coudray Data Update

- As the dataset is **383 GB**, we are not able to retrieve the entire dataset. Moreover, we do not have the resources to train a model on such a huge dataset. Dealing with this dataset is not feasible for us.
- We think we should focus on this project, and if need be explore another domain project using DL techniques.
- GitHub Issue for the entire discussion

Discussion

- We will be going forward with the **AMD classification exploration** (literature review and pipeline codebase) after this report.
- Along with trying out the semi-supervised technique that we added we will be finalizing the segmentation pipeline before our next report.

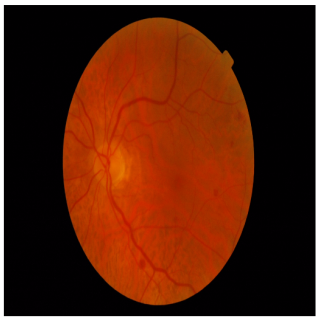

Figure 2. Image

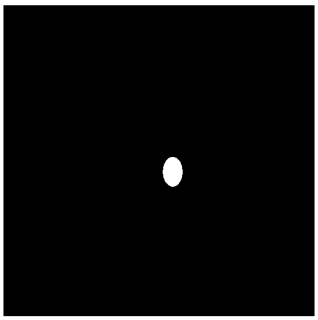

Figure 3. Mask

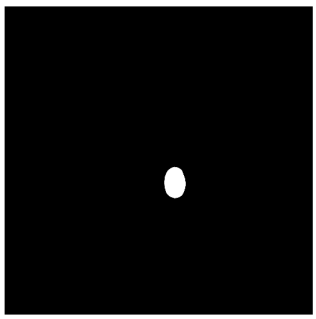

Figure 4. Prediction