.

Title	Saliency Prediction
Student Name	Jubayer Hossain Arnob
Student ID	1813124642
Email address	Jubayer.arnob@northsouth.edu

Overall Tasks:

- To predict the saliency map using several saliency predictions models
- Compare the predicted saliency map with **Typically Developed (TD)** fixation maps
- Compare the same predicted saliency map with **Autism spectrum disorder (ASD)** fixation maps
- Analyze the performance of predicted saliency maps approximating TD and ASD fixation maps

Steps to follow:

1. Download the dataset from 'Saliency4asd.zip'. For each image in TrainingData/Images folder, the folder TrainingData/TD_FixMaps and TrainingData/ASD_FixMaps contain fixation maps of TD and ASD subjects. You can consider TrainingData/TD_FixMaps and TrainingData/ASD_FixMaps are the ground truth for the prediction. Given an image as an input, a saliency prediction model should generate a saliency prediction map that approximates corresponding (a) TD and (b) ASD map.

2. Now, become familiar with the website http://saliency.mit.edu/results_mit300.html. This website mentions popular saliency prediction models. From this list, pick at least three (3) models for which codes (preferably Matlab but others also ok) are available. Then generate saliency prediction maps for each image in TrainingData/Images. In this way, you will get three sets of predicted saliency maps. Do not try to implement any model by yourself rather use the available codebase.

3. Next, compare each set of prediction maps with (a) TrainingData/TD_FixMaps and (b) TrainingData/ASD_FixMaps. For comparison, there are several evaluation metrics available here https://github.com/cvzoya/saliency/tree/master/code_forMetrics. Use at least three (3) evaluation metrics.

4. If there is x number of images in the dataset, each saliency model will provide x number of saliency maps. After applying each evaluation metric, you will get x number of performance values for (a) TD and another x number of performance values for (b) ASD. Report the average/mean performance of all values. Then, fill the following tables.

(a) For TD:

	CC	KLdiv	NSS
Model 1	0.50	3.19	0.24
Model 2	0.64	1.03	0.28
Model 3	0.48	2.38	0.29

(b) For ASD:

	CC	KLdiv	NSS
Model 1	0.47	4.05	0.19
Model 2	0.59	1.41	0.22
Model 3	0.45	2.93	0.23

5. Finally, write a report about the whole work and include your observation regarding the results you got. Provide a code link at the end of the report. Make sure to put a readme.txt file mentioning code running instructions.

Introduction

Autism Spectrum Condition (ASD) is a neurodevelopmental disorder that causes social and cognitive impairments. Because ASD has no treatment, early detection is essential for limiting its effects. For this, digital image processing brings a solution that analyze on eyes focus tracking and detects saliency. There are several saliency predictions models. This paper shows the analysis on 3 of those prediction models which are: Fast and Efficient Saliency (FES), SUN Saliency and Structural dissimilarity-based saliency (SDS - LC model). The analysis is based on comparison of three models predicted saliency maps approximating TD and ASD fixation maps. The researched findings suggests that visual attention in people with ASD is driven by atypical saliency.

Related Work

“Predicting saliency maps for ASD people” [5] Work done by Alexis Nebout, Weijie Wei, Zhi Liu, Lijin Huang and Olivier Le Meur. To carry out the evaluation, they used quality metrics used in the MIT benchmark. Many approaches for comparing scanpaths and saliency maps were discussed by e Meur and Baccino [6]. Only two measures were employed to compare four saliency models for evaluation. On Jian Li's dataset [7], Riche et al. evaluated 12 saliency models with 12 similarity measures. They compared how measurements rank saliency models and reported which metrics cluster together, but no explanations were provided.

Method

Software used – Matlab2021b. [8]

First step is to get the dataset [1] which contains 300 input images, td fixation map and ASD fixation map. Use input images to predict the saliency map using selected 3 saliency predictions models. This will lead to have 3 different output folders with corresponding saliency map. Models: [2]

- FES (Functional electrical stimulation) [9]
- Sun saliency [10]
- SDS_LC (Structural dissimilarity-based saliency) [11]

Now as saliency map for each model has been generated. Next task is to compare the corresponding saliency maps with typically developed fixation map and later with autism spectrum disorder fixation map. Here is the thing, in this work three different evaluation metrics are used to get the value. Which are: [3]

- CC (Correlation Coefficient)
- KLdiv (Kullback–Leibler divergence)
- NSS (Normalized Scanpath Saliency)

As there are 300 images for each map, we need to get the average score as in sum of all 300 scores divided by 300.

Collect all values for each model with each evaluating metrics for both td and ASD. Create a data table with these values for each ground truth (td, ASD). Now, Analyze the performance of predicted saliency maps approximating TD and ASD fixation maps.

Experiment

Running the Models

To run the prediction models first set the input folder directory, output folder directory and set extension format to .png. and run the program. Except model 1, other too models are working on single input and output. So, modify it the way so that it can iterate through all 300 images and save all the outputs in the result directory. For output model 2 and model 3 has imagesc library to show scaled image output. To save the image like this in directory used this similar approach [`imwrite(getframe(gcf).cdata, 'myfilename.png')`]. Now time to run the prediction models. Saved saliency maps for each models in 3 different directories. Samples in figure1.

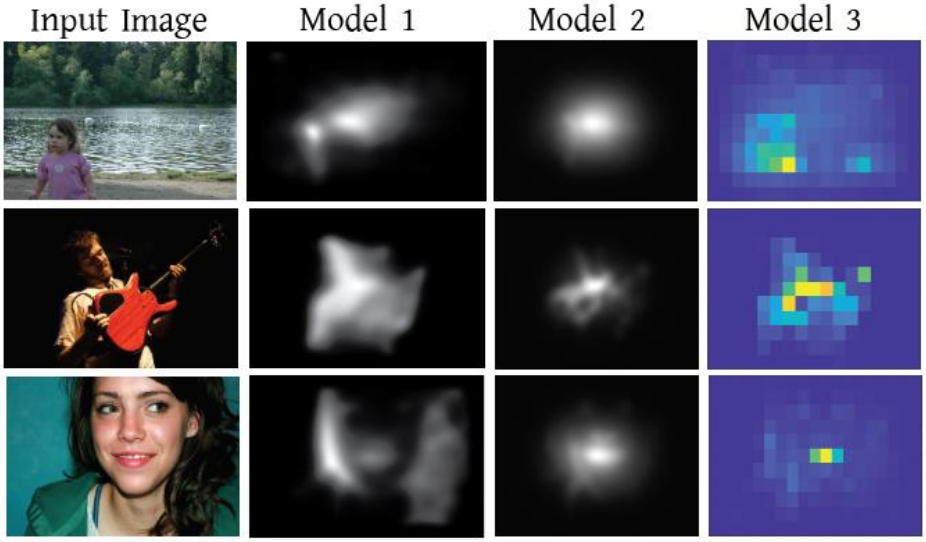

Figure 1: Model Output Samples

Using evaluation metrics to compare

Set 2 input directories for saliency map and fixation map, iterate through all the images and calculate score in each iteration. Sum all the score and divide by 300 to get the average value which is the main output required. An additional axis of organization is whether the metrics measure a similarity or a dissimilarity between prediction and ground truth, which is relevant for interpreting metric scores. Here similarity class is NSS and CC. dissimilarity is KL.

Analyze the performance

From the chart, it is seen that in respect to CC and KL metric, Model 2 is doing better than other models. KL metric works like lower value is the better model as it is dissimilarity

model. CC and NSS are similarity models. So, high score in this is the best model. So, according to metric CC and KLdiv Model 2 is the winner. Which is Sun Saliency Model. And according to metric NSS, model 3 as in SDS(lc version) is doing better with a close competition with Model 2. By this we are convinced that the better predicting model among these 3 are as follow: *Model 2 > Model 3 > Model 1.* A considerable thing in these results is center bias.

Table (a) For TD:

	CC	KLdiv	NSS
Model 1	0.50	3.19	0.24
Model 2	0.64	1.03	0.28
Model 3	0.48	2.38	0.29

Table (b) For ASD:

	CC	KLdiv	NSS
Model 1	0.47	4.05	0.19
Model 2	0.59	1.41	0.22
Model 3	0.45	2.93	0.23

Another observation through the chart is that comparison score with ASD fixation map is comparatively lower than that with typical developed fixation map as metric CC and NSS, and higher while using KLdiv. So, it shows that predicting accuracy is better in table(a) which is based against table(b). In other word, having autism spectrum condition makes person focus less accurately like normal people as focus attention is not normal like others.

Conclusion

So, after the assignment work it is understood that, this field of work can make an better opportunity to detect ASD issues and help people as it has no treatment, therefore early detection can be huge benefit. According to this work, it is possible that there can be many better or far better models out there that can do better prediction and detection. And by enhancing the work and with better tools it can have better future scopes.

Reference

1. Dataset: https://drive.google.com/file/d/1Aomt2tor41-qHTdFfRaa7c2oAKUBQlUX/view?usp=sharing
2. Models: http://saliency.mit.edu/results_mit300.html
3. Evaluation metrics: saliency/code_forMetrics at master · cvzoya/saliency (github.com)
4. https://www.arxiv-vanity.com/papers/1604.03605/
5. https://hal.inria.fr/hal-02264907/document
6. (PDF) Methods for comparing scanpaths and saliency maps: Strengths and weaknesses (researchgate.net)
7. Learning saliency-based visual attention A review (umn.edu)

8. Matlab Tool - R2021b - Updates to the MATLAB and Simulink product families - MATLAB & Simulink (mathworks.com)
9. Functional electrical stimulation (FES) | MS Trust https://mstrust.org.uk › functional-electrical-stimulation-fes (google.com)
10. SUN: A Bayesian framework for saliency using natural statistics https://jov.arvojournals.org › article (google.com)
11. Saliency detection based on structural dissimilarity induced by ... https://www.researchgate.net › ... › Images (google.com)

Code availability

Git link: jharnob30/Sailency_Prediction_Matlab (github.com)

// Share the link (like GitHub, google drive, etc.) of your all code here. Within your code directory, please include running instructions in a readme.txt file.