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Ministry of Higher Education and Scientific Research
وزارة التعليم العالي و البحث العلمي

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Science and Technology Faculty
Mathematics and Computer Science Department

End-of-study Thesis

in view of obtaining a Master's diploma in Computer science

Option : Software and Distributed Systems Engineering

Automatic detection of Diabetic Retinopathy using the Transfer Learning technique

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Defense Jury:

Mr. : -
Mr. : -

Promotion : 2021/2022

Dedication

“

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- Taqi yeddine

acknowledgements

Abstract

Half a century ago, India was suffering from a curable blindness outbreak. As a developing country with near-non-existent potential, Dr. Govindappa Venkataswamy decided to take the initiative and work on their treatment. It's like a fantasy that has a hospital with its own 11-bed account to treat all those patients, and even make them the choice to pay without them.

Today, according to APS reported, 14 percent of Algerians are blinded by diabetes, and early detection of patients would have protected These and others in the coming days. My mission as a software engineer is to facilitate the exploitation of artificial intelligence to do research that enables the use of artificial intelligence in protecting these people and early detection of the disease before it is detected, this is what we will work on in our research using learning transfer techniques and exploring their effectiveness.

Keywords : Diabetic retinopathy, deep learning, classification, Convolutional Neural Network, Transfer Learning, computer vision.

Résumé

Il y a un demi-siècle, l'Inde souffrait d'une épidémie de cécité curable. En tant que pays en développement au potentiel quasi inexistant, le Dr Govindappa a décidé de prendre l'initiative et de travailler sur leur traitement. C'est comme un fantasme qui a un hôpital avec son propre compte de 11 lits pour traiter tous ces patients, et même leur faire choisir de payer sans eux.

Aujourd'hui, selon l'agence APS, 14 pour cent des Algériens sont aveuglés par le diabète, et la détection précoce des patients aurait protégé Ces et d'autres dans les prochains jours. Ma mission en tant qu'ingénieur logiciel est de faciliter l'exploitation de l'intelligence artificielle pour faire des recherches qui permettent l'utilisation de l'intelligence artificielle dans la protection de ces personnes et la détection précoce de la maladie avant qu'elle ne soit détectée, c'est ce sur quoi nous allons travailler dans nos recherches en utilisant apprendre les techniques de transfert et explorer leur efficacité.

Mots clés : Rétinopathie diabétique, apprentissage profond, classification, réseau de neurones convolutifs, apprentissage par transfert, vision par ordinateur.

قبل نصف قرن كانت الهند تعاني من تفشي العمي القابل للشفاء وصلت الى 45 مليون مصاب ,كدولة نامية وبإمكانيات شبه معدومة قرر الدكتور جوفيندابا فينكاتاسوامي اخذ المبادرة والعمل على معالجتهم الأمر اشبه بخيال اسس مشفي بحسابه الخاص يضم 11 سرير لعلاج كل أولائك المرضي ,وبل وجعل لهم خيار الدفع من عدمهم ,اليوم Aravind هو المستشفي الأول في العالم لمرضي العين ,ولايزال يخير المرضي بين الدفع او لا مع ضمان توفير اجود الخدمات مهما كان الخيار

حسب وكالة الأنباء 14 بالمئة من الجزائريين يصابون بالعمي بسبب إعتلال الشبكية السكري ,الكشف المبكر على المرضي كان سيحمي هؤولاء وغيرهم مما سيصابون في الأيام القادمة.

مهمتي كمهندس برمجيات هو تسهيل استغلال الذكاء الصناعي لعمل بحوث تمكن من استعمال الذكاء الصناعي في حماية هؤلاء والكشف المبكر عن المرض قبل تفاشيه ,هذا ماسنعمل عليه في بحثنا بإستعمال تقنيات نقل التعلم واستكشاف مدي فعاليتها .

كلمات مفتاحية :

اعتلال الشبكية السكري ، التعلم العميق ، التصنيف ، الشببكة العصبية التالفيفية ،نقل التعلم،رؤية الحاسوب.

Contents

List of Figures

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Listings

list of abbreviations and acronyms

CNN	*convolutional neural network.*
FC	*Fully Connected layers.*
MLP	*Multy Layer Perceptron.*
AI	*artificial intelligence.*
ANN	*Artificial Neural Networks.*
TL	*Transfer learning.*
TF	*TensorFlow.*
DR	*Diabetic retinopathy.*
NO DR	*No Diabetic retinopathy.*
CPU	*Central Process Unit.*
RAM	*Random Access Memory .*
GPU	*Graphics Processing Unit.*
ViT	*Vision Transformer.*

Introduction General

Introduction General

Context

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Organisation of Work

This work is organized into five chapters followed by a general conclusion, each of which is part of the work of this project, whether theoretical or practical:

- **Chapter 1 ::Medical Background**

  In this chapter we will discover the human eye and its composition and learn more about diabetic retinopathy and its stages.

- **Chapter 2 ::Computer Vision and Image Processing**

  In this chapter we will learn how the human visual system works and what has been reproduced in computer vision, we will understand more the concept of computer vision and the latest scientific research in it, we will learn about the ways in which images are analyzed and processed as well.

- **Chapter 3 ::Convolutional Neural Networks**

  In this chapter, we'll learn about the Convolutional Neural Networks and the most important architectures models from which they were built.

- **Chapter 4 ::Transfer Learning**

In this chapter, we'll learn what transfer learning is, what types and strategies it is, and we'll also talk about ways to train and evaluate the model.

- **Chapter 5 ::Achievements**

  In this chapter we will learn how the human visual system works and what has been reproduced in computer vision, we will understand more the concept of computer vision and the latest scientific research in it, we will learn about the ways in which images are analyzed and processed as well.

- **Conclusion and perspectives** I'll talk about what I've discovered throughout my journey writing the memo, summarizing my conclusion, as well as my future goals for completing this project.

Name of chapter

0.1 Introduction

Most computer science research tries to build a human-like robot capable of working just like humans. Even emotional characteristics are not impossible for such robots. Using a sensor, the robot feels the temperature in the surrounding environment. Using facial expressions, it is possible to know if arson is sad or happy. Even things that seem impossible may eventually be just difficult.

in visual processing vary from 25%

0.2 image processing and analysis

0.2.1 Image Digital

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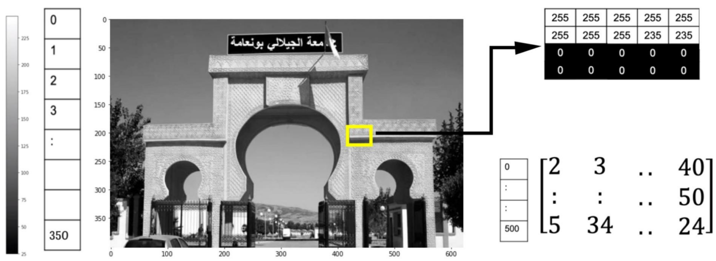

Figure 1: Understanding the components of the image.[2]

- **Binary Images:** Phasellus ultrices, lacus eget porttitor volutpat, erat diam pulvinar lorem, non scelerisque augue metus id elit. Etiam a facilisis mi. Praesent eget laoreet lorem, sit amet malesuada augue. Suspendisse ligula mauris, pellentesque sed lectus non, consequat tempor massa. Nullam tempus laoreet neque, non ultricies erat feugiat ut.
- **Gray Scale Images:** Phasellus ultrices, lacus eget porttitor volutpat, erat diam pulvinar lorem, non scelerisque augue metus id elit. Etiam a facilisis mi. Praesent eget laoreet lorem, sit amet malesuada augue. Suspendisse ligula mauris, pellentesque sed lectus non, consequat tempor massa. Nullam tempus laoreet neque, non ultricies erat feugiat ut.

- **Color Images:** Phasellus ultrices, lacus eget porttitor volutpat, erat diam pulvinar lorem, non scelerisque augue metus id elit. Etiam a facilisis mi. Praesent eget laoreet lorem, sit amet malesuada augue. Suspendisse ligula mauris, pellentesque sed lectus non, consequat tempor massa. Nullam tempus laoreet neque, non ultricies erat feugiat ut.

0.2.2 Color Image Formation

Consider the following image Figure 2, it's a combination of red, blue and green images, it's sometimes referred to as an RGB image. This is just one of many color representations.

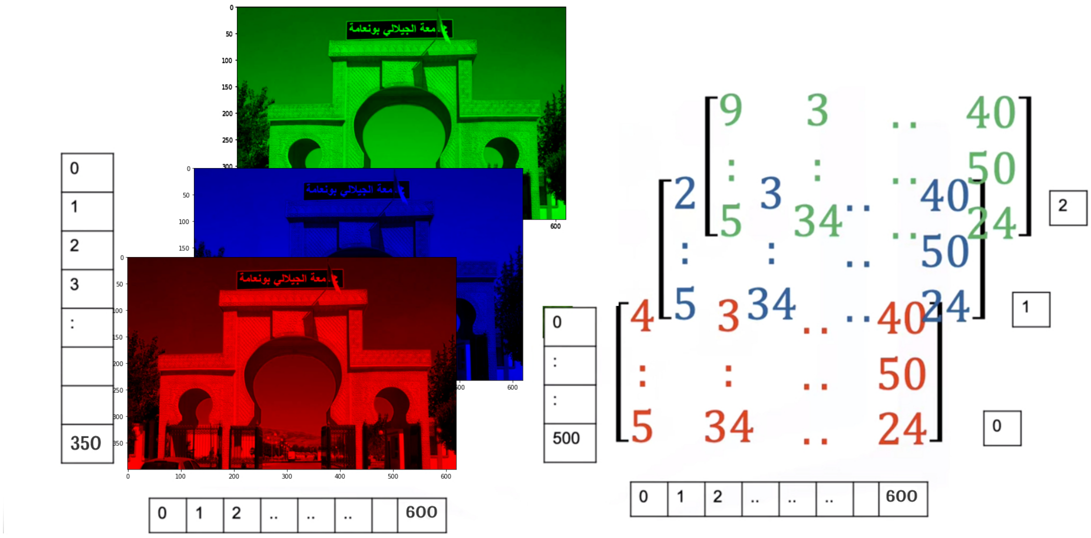

Figure 2: Color Image Formation.

0.2.3 Noise

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$$S/N_{ratio} = \sum_{(i,j)} f^2(i,j) \Big/ \sum_{(i,j)} v^2(i,j) \tag{1}$$

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Types of Noise

The three most commonly encountered types of noise are Gaussian noise and salt and pepper noise , Speckle Noise [2].

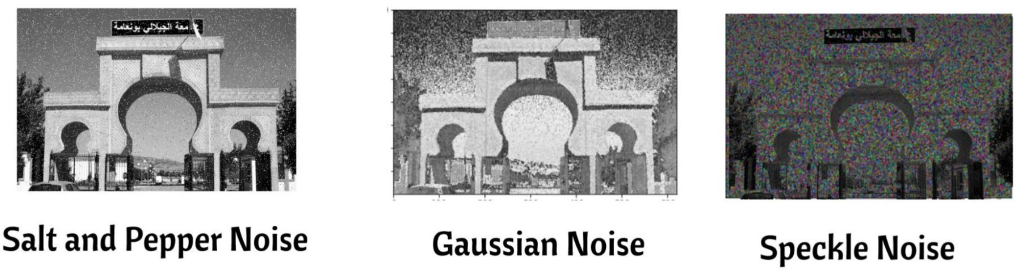

Figure 3: Types of Noise.

0.2.4 Manipulating Images

In the first section, an introduction to the main geometric transformations of images will be covered. We will look at some examples the of scaling, translation, rotation, affine transformation, perspective transform, and cropping of images.

Affine Transformations

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Example using opencv 2 python:

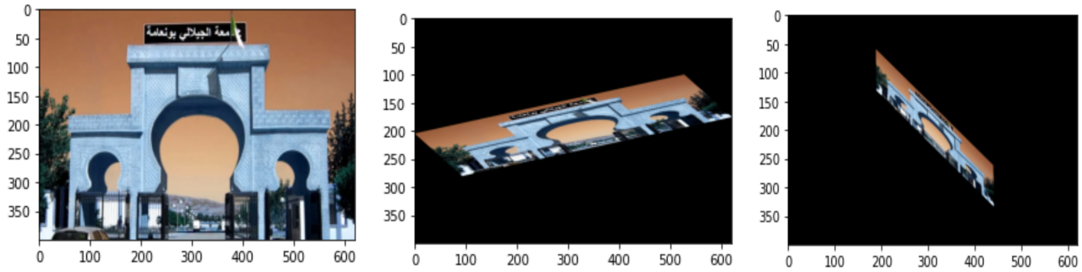

Figure 4: Example using opencv 2 python.

Remapping (Flipping)

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- To accomplish the mapping process, it might be necessary to do some interpolation for non-integer pixel locations, since there will not always be a one-to-one-pixel correspondence between source and destination images.

- We can express the remap for every pixel location (x,y).

$$g(x, y) = f(h(x, y)) \tag{2}$$

- where g() is the remapped image, f() the source image and h(x,y) is the mapping function that operates on (x,y).

- Let's think in a quick example. Imagine that we have an image I and, say, we want to do a remap such that:

$$h(x, y) = (I.cols{-}x, y) \tag{3}$$

- What would happen? It is easily seen that the image would flip in the x direction. For instance, consider the input image observe how the flag changes positions with respect to x (considering x the horizontal direction):

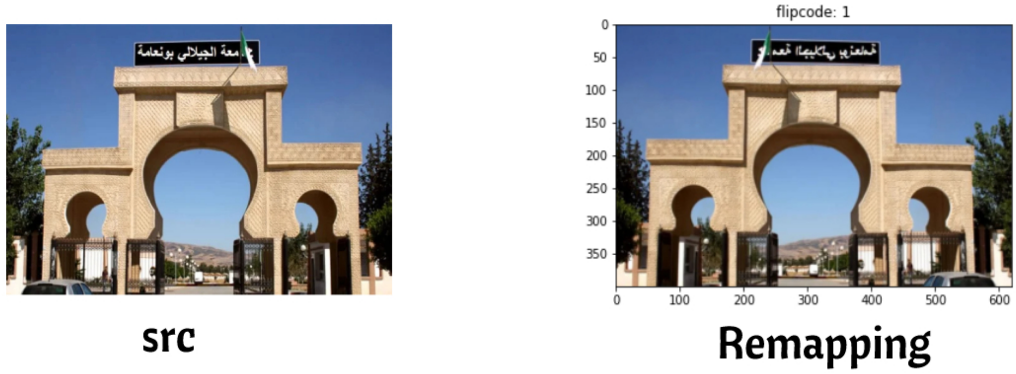

Figure 5: Example using opencv 2 python.

Cropping

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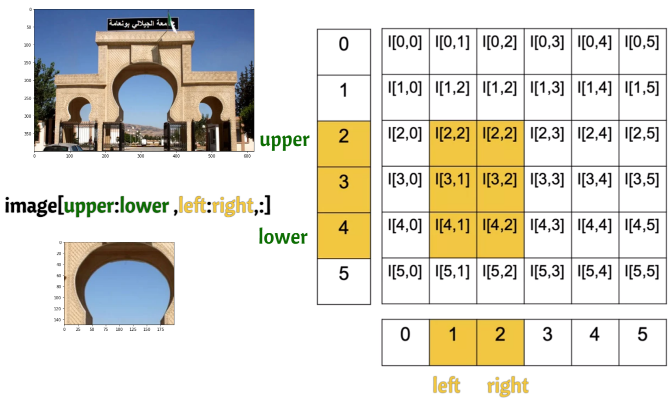

Figure 6: Example using opencv 2 python.

Changing Image Pixels

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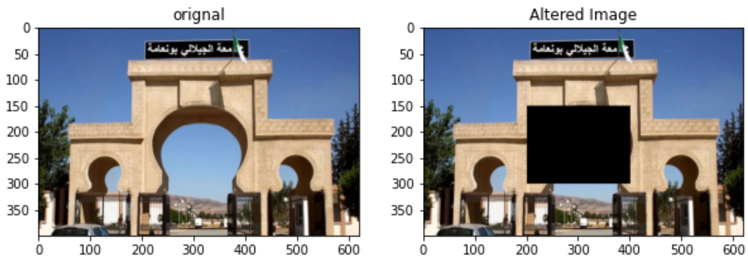

Figure 7: Changing image pixels.

0.2.5 Image Arithmetic and Bitwise Operations

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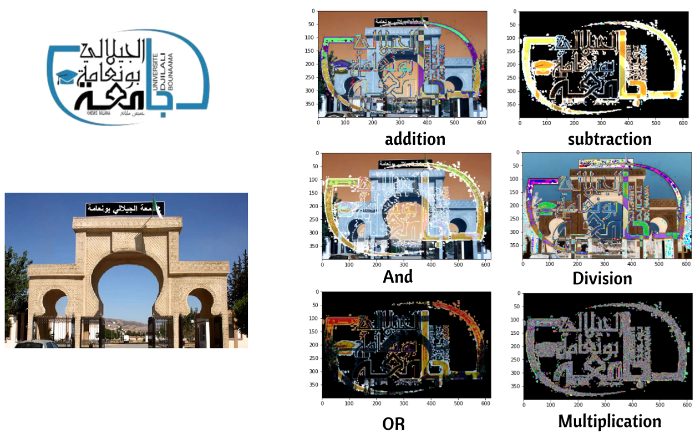

Figure 8: Image Arithmetic and Bitwise Operations.

0.3 Image Analysis

0.3.1 Detecting the corners

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Example:

Figure 9: Detecting the corners Example.

0.3.2 Good features to track

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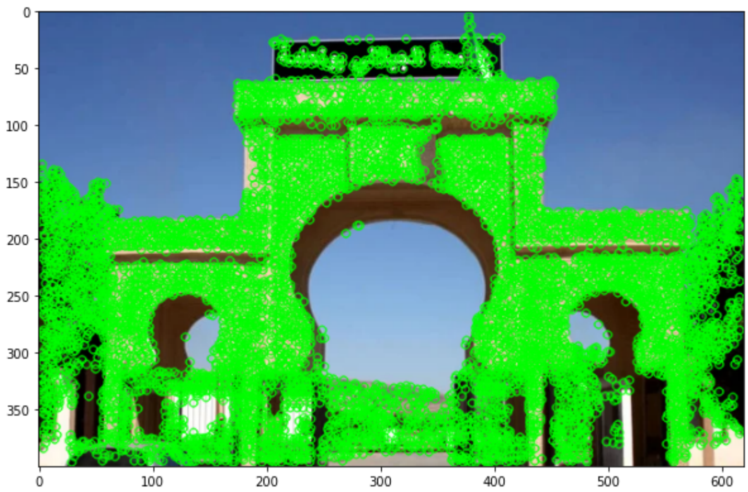

Figure 10: Good features to track.

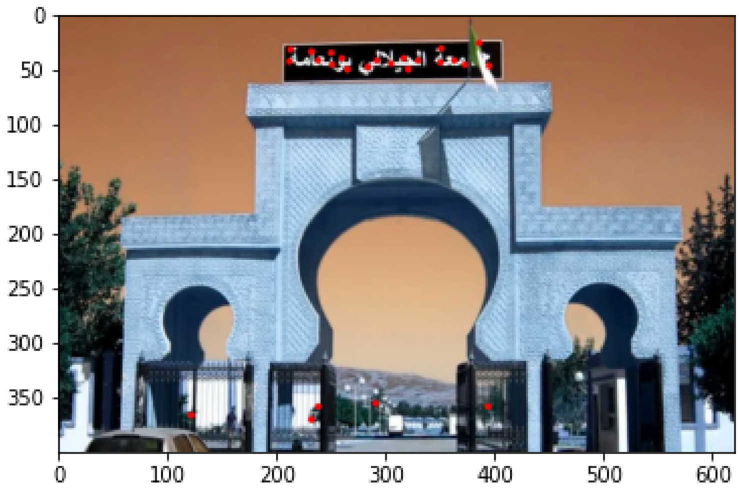

Figure 11: Good features to track Example.

From the figure, you can see that only when 1 and 2 are above a minimum value, min, it is considered as a corner(green region),in our example, he identified the entrance panelas feature ,with the three gates.

0.3.3 Scale-invariant feature transform (SIFT)

Donec augue mauris, ultrices vitae justo aliquam, elementum mollis odio. Aenean eleifend nulla eros, non vestibulum dolor fermentum ut. Vivamus nec arcu vel magna eleifend porttitor id at dui. Nulla in laoreet justo. Integer volutpat et justo ac rutrum. Nullam hendrerit risus eu tempus cursus. Cras rhoncus ligula eu libero rhoncus lobortis. Aliquam aliquam ipsum et feugiat hendrerit. Donec lacinia neque vitae nibh egestas, sit amet iaculis nisi imperdiet. Vestibulum quis egestas quam, vel dictum eros. Ut vitae tempor metus. Fusce ut suscipit ligula. Quisque eu nisi consequat, cursus mi in, pharetra nunc. Fusce id massa risus. Cras sit amet maximus nisi, eget placerat risus. Morbi gravida lacus sed libero tincidunt aliquam.

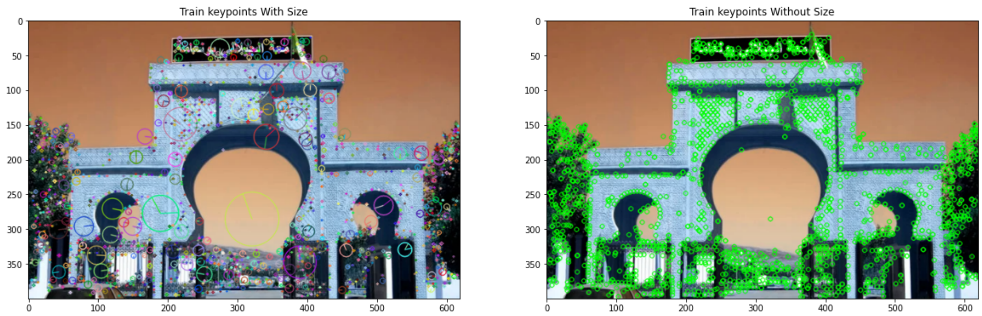

Figure 12: SIFT Example.

0.3.4 Features from accelerated segment test (FAST)

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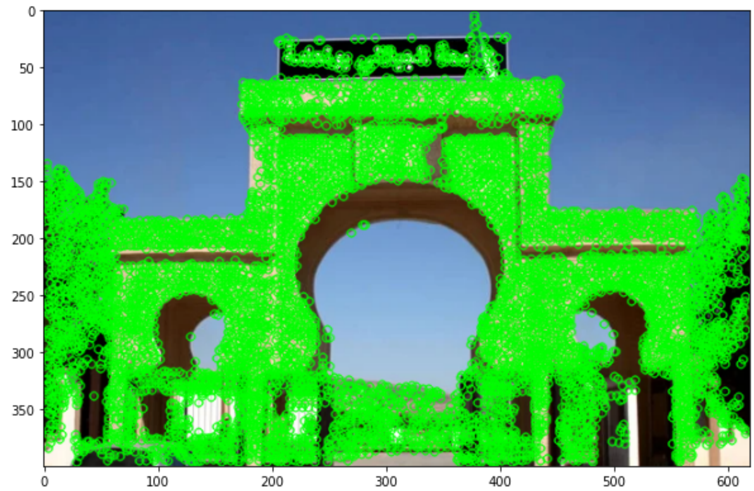

Figure 13: FAST.

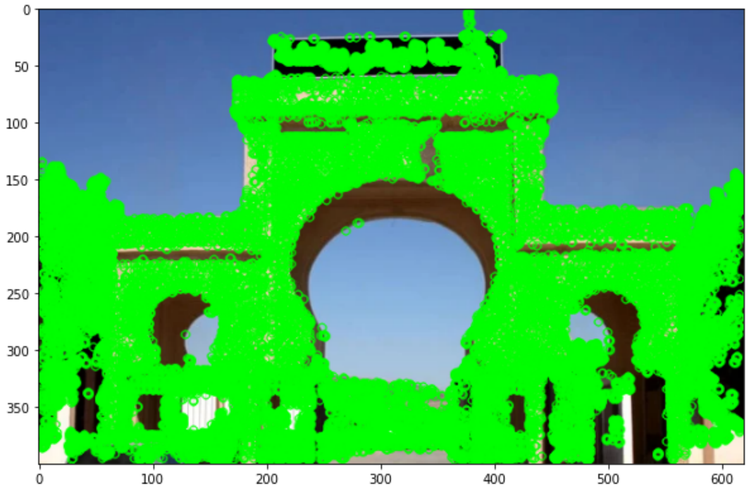

Figure 14: FAST2.

0.3.5 Oriented FAST and Rotated BRIEF (ORB)

Cras rhoncus ligula eu libero rhoncus lobortis. Aliquam aliquam ipsum et feugiat hendrerit. Donec lacinia neque vitae nibh egestas, sit amet iaculis nisi imperdiet. Vestibulum quis egestas quam, vel dictum eros. Ut vitae tempor metus. Fusce ut suscipit ligula. Quisque eu nisi consequat, cursus mi in, pharetra nunc. Fusce id massa risus. Cras sit amet maximus nisi, eget placerat risus. Morbi gravida lacus sed libero tincidunt aliquam.

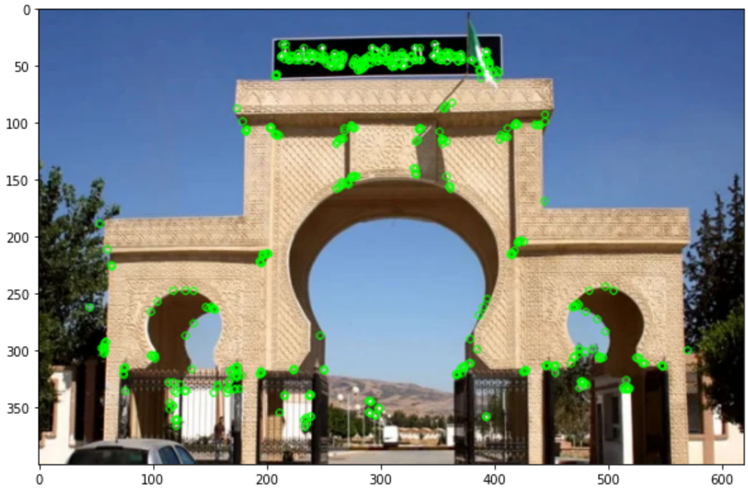

Figure 15: ORB.

0.4 Conclusion

In this chapter, Cras rhoncus ligula eu libero rhoncus lobortis. Aliquam aliquam ipsum et feugiat hendrerit. Donec lacinia neque vitae nibh egestas, sit amet iaculis nisi imperdiet. Vestibulum quis egestas quam, vel dictum eros. Ut vitae tempor metus. Fusce ut suscipit ligula. Quisque eu nisi consequat, cursus mi in, pharetra nunc. Fusce id massa risus.

Cras sit amet maximus nisi, eget placerat risus. Morbi gravida lacus sed libero tincidunt aliquam.

Conclusion and perspectives

General Conclusion

In a 2017 experiment conducted by google's AI research team "TF with Retinal Imaging", it was discovered that many doctors do not agree on the same stages of the DR, ranging from 60 to 65 percent, which is what explains the complexity of the DR. For me I visited Dr. Najari, who was really very cooperative, explaining to me all the machines he works on and the way to detect the patient and others, and also I spoke with Dr. Taher Hamouma, both specialists in ophthalmology, and their assessment was that it is not useful because there no one standard for evaluation in the stages of DR but each country has standard, also I had contact with medical students at Blida University who studied on the retina and who told me that the evaluation was recently changed and another adoption.

On a personal level, I had read several articles and some books and even read the 4th year of medicine lessons from Dr. Majdi shuhomy, which he a Membership of the FRCS Glasgow. I can say in the end it is very difficult to work on a model to evaluate the stages of DR as an individual and it takes a laboratory and specialists at least an ophthalmologist with a specialist in physics to suggest more tricks in the process of processing images. But our experience is very useful to make it easy for those who come after us to start from where we finished and this is what I will work on by making all my work open source, Today we urgently need artificial intelligence to detect the DR before it is detected and reduce the incidence of blindness in Algeria. With the advent of transfer learning, facilitating experiments, and training our models, we can say that we are closer than we used to achieving this dream at NIPS 2016. Andrew Ng spoke and said: If supervised learning has been the main driver of artificial intelligence in recent years, transfer learning is its main driver in the coming years.

The importance of transfer learning has played a key role in transferring research in the field of AI from specialists and large bodies to individuals and people with their simple abilities, and yet all the models on the transfer learning are trained on the Image-Net of objects present in our world, which are almost not similar to the elements that exist in the medical Image.

In my opinion, artificial intelligence in the medical field needs to work its own standard different from other fields for its importance on the one hand and for different worlds, so to speak, we today desperately need to make an Image-Net-like competition that is specialized only in the medical field under the supervision of doctors and specialists then we can achieve the required progress.

However, what we have experienced is a simple experience in transfer learning in Supervised learning with Self-Supervised, the Self-Supervised and truth, which was called semi-supervised learning, and then derived from Self-Supervised, which was officially after the tweet of the spiritual Godfather of Deep Learning Yann LeCun in 2019. while by informing me of the experiences and achievements of the others and the latest knowledge, I can say that the medical field in AI will be more promising in the Unsupervised learning because you do not need a doctor to evaluate during the training process, but it will only be after the end of training. There are many promising technologies such as Open Set Learning (OSL) and others that are really worth experimenting with and I would advise those who come after me to experience these techniques.

Perspectives

What we have addressed in this research is just a start and there are a lot of defects that we will work to cover that we can shorten as follows:

- all codes will be pulled on my GitHub [2] throw to be open source and scalable, and editable, and will be in notebook jupyter files.
- Use Vision Transformer (ViT) and try it with other models.
- Use 3D-Unet with a different database.
- Use hypergraph neural networks and try it.
- Apply the concept of Self-Supervised to the same database.

I will try to make it the beginning of evaluating useful techniques in the medical field, especially the eye, My goal will be to simplify the use of artificial intelligence techniques for researchers.

Bibliography

[1] Kenneth Dawson-Howe. *A practical introduction to computer vision with opencv.* John Wiley & Sons, 2014.

[2] *Transfer Learning Techniques In Images Medical.* June 2022.

Appendices

Appendix A

Definitions