IDEATION ON DEEP LEARNING FUNDUS IMAGE ANALYSIS FOR EARLY DETECTON OF DIABETIC RETINOPATHY:

Diabetics is a globally prevalent disease that can cause visible microvascular complications such as diabetic retinopathy and macular edema(swelling in the part retina) in the human eye retina, the images of which are today used for manual disease screening and diagnosis. This labor-intensive task could greatly benefit from automatic detection using deep learning technique. Here we present a deep learning system that identifies referable diabetic retinopathy comparably or better than presented in the previous studies, although we use only a small fraction of images (<1/4) in training but are aided with higher image resolutions. We also provide novel results for five different screening and clinical grading systems for diabetic retinopathy and macular edema classification, including state-of-the-art results for accurately classifying images according to clinical five-grade diabetic retinopathy and for the first time for the four-grade diabetic macular edema scales. These results suggest, that a deep learning system could increase the cost-effectiveness of screening and diagnosis.

PROBLEM STATEMENT:

Eye conditions related to diabetes at productive age is a worldwide health problem with a large amount of budget allocated by the World Health Organization. In addition to this, the large amount of available information (images, signals and clinical data) to study eye condition, and the need of design new deep learning strategies as a support tool of different ocular diseases, make this proposal as a doctorate challenge from the point of engineering with social responsibilities.

- To solve global issues in vulnerable populations. Hence, our hypothesis is that deep learning techniques applied to ocular images may improve the diagnosis of eye conditions related to diabetes. Moreover, the integration of local features such as blood vessel patterns, exudates, microaneurysm, drusen, hemorrhages, abnormalities of the macula and others could improve the classification of different eye conditions related to diabetes, but that has not been explored deeply yet.
- The focus of this research is to develop deep learning models for analysis of ocular images, that combine the detection of local labels (features) and global labels (grade of diabetes-related eye conditions) to support medical personnel in a faster and more precise diagnosis. The main research questions of this work are: How to apply deep learning techniques to ocular images to improve the diagnosis of eye conditions related to diabetes?
- Cloud the integration of domain knowledge improve the classification of different eye conditions related to diabetes? Specifically, the guiding goals of this research are:

Main goal To develop interpretable deep learning methods for automatic analysis of ocular images to support the diagnosis of different diabetes-related conditions.

- To design and implement a deep learning method for automatically identifying different eye features (e.g. exudates, microaneurysm, blood vessel and optic disc segmentation) useful for diagnosis of diabetes-related conditions.
- To design and implement a deep learning model to automatically classify the grade of different diabetes-related conditions.
- To systematically evaluate the performance of the method on different dataset for diagnosis of diabetes-related conditions.
- A CNN that combines a patches classifier used for detecting local abnormalities (exudates) stacked with the raw eye fundus image as a fourth-channel array for diabetic macular edema diagnosis.
- A three-stages strategy based on deep learning methods to support glaucoma diagnosis with relevant intermediate medical information such as: segmentations of part of the eyes and the morphometric features that describes these parts.
- A deep learning late fusion strategy that merges features extracted from images with polar or cartesian morphometric features to support glaucoma diagnosis.
- A method to classify three diabetes-related conditions using optical coherence tomography volumes based on a CNN (OCT-NET). The CNN outperformes other state-of-the-art models, generating clinically interpretable information to support the medical diagnosis.
- The design of a deep learning method to estimate the retinal thickness map from SD-OCT volumes.