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Diabetic Retinopathy Detection Smartphone App Using Tensor Flow

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ABSTRACT: Diabetic retinopathy is a medical term for a disorder that damages the retina and may cause blindness. The illness is most common in people in their working years, and it may lead to severe eyesight loss if left untreated. The continual execution of deep neural organizations on cell phone stages to distinguish and organize diabetic retinopathy from eye fundus images is presented in this study. This execution builds on a previously announced execution by considering each of the five phases of diabetic retinopathy. Binary deep neural organisations are built at principal, one for recognising four phases and the other for further defining the last step into additional two stages, using motion learning and fundus photos from the Eye PACS and APTOS datasets. Then it is shown how these prepared organizations are transformed into a mobile phone program, with Android as well as iOS modifications, to deal with images captured by cell phone cameras on a continual basis. The application is planned so that fundus pictures can be caught and handled progressively by cell phones along with focal point connections that are industrially accessible. The grew constant cell phone application gives a cost effective and generally open methodology for leading first-finish diabetic retinopathy eye tests in quite a while or regions with restricted admittance to fundus cameras and ophthalmologists.

KEYWORDS: Android, Diabetes, Diabetic retinopathy, Eye Tests, Tensor Flow.

I. INTRODUCTION

The most prevalent causes of blindness in individuals all arounds the world is retinopathy. According to a research, 239 million people worldwide were affected in 2010, with over 7.7 million in the United States alone. According to the most recent estimates, the number of Americans with diabetic retinopathy will almost quadruple by 2050, from 7.7 million in 2010. Because of its enormity and the severity of the devastation it causes, most health institutions throughout the world have prioritized early detection and treatment [1], [2].

Diabetic retinopathy changes the structure of the retina's vasculature, which includes the major blood vessels that provide oxygenated blood and nutrients to the retina's various sections. In certain individuals with diabetic retinopathy, veins augment and release liquid, bringing about irregularities including hard and delicate exudates. Other signs and symptoms include the creation of abnormal new blood vessels, blood vessel obstruction, and blood leakage (hemorrhages) into a healthy retinal region [3], [4]. The right distinguishing proof of every single expected irregularity, like hard and delicate exudates, hemorrhages, and vein impediments, is expected to recognize the signs of diabetic retinopathy. Subsequently, distinguishing and fragmenting the various parts of the retina, like veins, the optic circle, and numerous other strange indications of a debilitated eye, will be a valuable methodology for accomplishing a dependable determination of DR harmed eye. The retina vasculature is disconnected from the fundus picture for cautious examination of different physical changes in the engineering of these supply routes, like distance across, stretching point, and impediment, which is one of the significant components being taken a gander at. In the past, a manual segmentation of the retinal fundus picture was used to diagnose these retinal symptoms. Because the process is time-consuming, labor-intensive, and very sophisticated, it needs the skill of an ophthalmologist. Many methods were created by researchers to aid in the identification of these anomalies in retina fundus pictures as a result of key breakthroughs in machine learning and artificial intelligence sectors. Ophthalmologists, for example, may utilize a correctly segmented vessel to analyze and diagnose illness by spotting the development of additional vessels or fluids, as well as their forms and sizes. Many studies have utilized or suggested different methodologies, some of which focused primarily on the segmentation of distinct retinal characteristics to investigate abnormalities[5]–[7].

Various ideologies also use a more expansive philosophy, such as developing and implementing an AI computation to detect a fundus image as strong or unlucky at various stages of the ailment. Diabetes is a condition in which your blood glucose, often known as glucose, is too high. Your major source of energy is blood glucose, which comes from the food you eat. Insulin is a pancreatic hormone that facilitates in the absorption of glucose into cells for energy generation. Your body does not always produce enough or any insulin, or it does so in an inefficient manner. Glucose remains in your scattering and does not show up on your phones in this way. Having an unreasonable measure of glucose in your blood could provoke clinical issues for a

really long time. Notwithstanding the way that there is no answer for diabetes, you could take attempts to administer it and remain sound. Diabetes is furthermore insinuated as "a sprinkle of sugar" or "peripheral diabetes." Such kind words praise that somebody doesn't have diabetes or has a milder sort of the defilement, but diabetes impacts everybody. As demonstrated by the International Diabetes Federation (IDF), there are presently about 460 million adults from one side of the world to the other encountering diabetes which is the fundamental wellspring of visual shortcoming in most countries. Diabetic Retinopathy (DR) is an eye retinal infection that can instigate visual inadequacies. DR is achieved by microvascular disarrays of diabetes reflected by morphological variations in the eye fundus. Diabetes is the fourth most ordinary justification behind mortality. As demonstrated by projections, the inescapability of diabetes would climb to 7.7% by 2030, with 336 million people beforehand encountering the condition. Diabetic retinopathy (DR) is a kind of diabetic retinopathy that is a fundamental wellspring of visual debilitation. There are two sorts of diabetes in the Dominican Republic. Around 75-95 percent of people with type I diabetes show confirmation of retinopathy 15 years after their first assurance. Following 16 years of affliction, the pervasiveness of type 2 patients is generally 60%. The DR influences up to 80% of the individuals who have had diabetes for over decade. The course of visual misfortune might be eased back by early determination and kept observing of DR. The diabetic retinopathy study (DRS) found that scatter laser photocoagulation may help minimize the probability of severe vision loss in 90 percent of diabetic retinopathy patients. Clinical professionals, such as ophthalmologists, are now employing non-mydriasis cameras to get pictures, and computer aided diagnosis systems to analyze or grade a patient's diabetes severity level[8]–[10]. These evaluations are based on a number of DR-related lesions. The leaking of blood and fluid on the retina causes these DR-related lesions, which are unhealthy objects. Because DR-related lesions have varied appearances on pictures, clinical professionals and CAD systems found it challenging to detect and quantify them[11]–[13].

A. Categories of diabetes

Type one, type two, as well as gestational diabetes are the greatest frequent kinds of diabetes.

a. Type one diabetes

Type 1 diabetes is a type of diabetes in that body has not induce insulin. If patient has type 1 diabetes, patient body does not produce insulin itself. The insulin-conveying cells in your pancreas are targeted and killed by human invulnerable structure. Despite the fact that diabetes type 1 may afflict anybody at any time throughout their lives, it is most often studied in young individuals and active adults. To remain alive, people with type 1 diabetes ought to acknowledge insulin reliably.

b. Diabetes Type two

Your body doesn't produce or use insulin well on the off chance that you have type two diabetes. Type two diabetes might strike at whatever stage in life, including youth. This sort of diabetes, then again, is more normal in moderately aged and more established grown-ups. Kind 2 diabetes is the most successive sort.

c. Gestational diabetes

A few ladies foster gestational diabetes while pregnant. When the child is conceived, this sort of diabetes ordinarily disappears. Be that as it may, assuming you've had gestational diabetes, you're bound to get type 2 diabetes sometime down the road. Diabetes analyzed during pregnancy could conceivably be type 2. The DR interaction is divided into five stages. There is no obvious retinopathy, and the DR is delicate and non-proliferative. The phases of mild NPDR, thoughtful NPDR, and proliferative DR (PDR) are considered separately. As part of the present approach for DR assurance, a professional eye master reviews concealed fundus photographs taken from the retina. Works have been represented in the composition to make this cycle more computerized, practical, and down to earth. In view of the achievement of substantial learning models in object distinguishing proof and image characterization applications, there has recently been investigations by significant neural connections to interpret DR through fundus photographs. Fundus cameras are a clinical gadget that is presently used to catch retina pictures for the identification of DR. They are costly, badly designed, and not accessible in all facilities, especially in distant regions. Cell phones are generally accessible nowadays, and there are additionally reasonable center focuses intended for cells to catch retina pictures, like the WelechAllyn Panoptic Ophthalmoscope and the D-EYE focal point. An image of two such center focuses is shown. For catching retina photos, these center focuses might be added to the front of a cell phone camera. The utilization of cell phones related to such concentrate focuses takes into consideration a reasonable and generally deployable methodology for starting DR separating places where fundus cameras and ophthalmologists are not accessible.

Diabetic retinopathy is a possibly blinding eye problem that might cause vision debilitation and visual impairment on the off chance that not treated rapidly. For some patients, be that as it may, early determination is troublesome in light of the fact that they know nothing about DR, particularly in its beginning phases. Diagnosing DR is at present a tedious and awkward interaction. Moreover, a specific clinical visit is expected for the determination. A cell phone application in light of a profound neural organization prepared with 16,798 fundus photographs from both the left and right eyes was intended to address these worries. The photograph dataset was made utilizing Kaggle's information base. The application was created to do parallel class characterization on photos taken with a cell phone camera progressively. The two characterization classifications are DR and no DR. In its most fundamental structure, diabetic retinopathy is an eye problem brought about by diabetes. It is brought about by harm to the retina's little veins and neurons. It might make veins in the Retina extend and spill, forestalling blood stream, as well as the production of strange fresh blood vessels. Spots or dark strings in vision, obscured vision, fluctuating vision, decreased shading vision, dull or discharge regions in vision, and vision misfortune are for the most part manifestations of diabetic retinopathy. Diabetic retinopathy is described by microaneurysms, defective veins, retinal swellings, the production of unusual fresh blood vessels, and harmed nerve tissues.

Treatment choices for diabetic retinopathy incorporate central laser treatment, dissipate laser treatment, and

vitrectomy. Medical procedure may generally decrease or stay away from diabetic retinopathy, in spite of the fact that it's anything but a total fix. Since it is a long lasting sickness, further retinal harm and vision misfortune are additionally conceivable. As an outcome, appropriate determination of the sickness is basic. In demonstrative strategies, for example, Fluorescein angiography and Optical intelligibility tomography, outside liquid or kicks the bucket are provided to the patient's eye after the Retinal Image is acquired. An Automated System that can anticipate Diabetic Retinopathy without the need of any outside specialist, then again, is a more agreeable and advantageous choice for the two clinicians and patients.

Diabetic retinopathy, which affects a huge number of people, is the leading cause of vision loss in working-age adults. In far off regions where clinical screening is troublesome, the Eye Hospital in India endeavors to distinguish and forestall this issue. At present, professionals go to these distant to take photos, which are then investigated and analyzed by exceptionally prepared subject matter experts. The objective is to use innovation to expand their endeavors by having the option to consequently screen photographs for infection and give data on the seriousness of the condition. This will be performed by making a Convolutional neural organization model that can investigate a patient's visual picture and decide the level of visual deficiency consequently. This computerized innovation could save a great deal of time and be utilized to evaluate the treatment methodology for diabetic retinopathy for an enormous scope.

Besides, because of different troubles, consolidating these profound learning forward leaps into DR screening is difficult. To start with, because of the way that DR reviewing intrinsically depends on the worldwide presence and dissemination of DR injuries, there are a couple of start to finish and perform various tasks learning strategies that can share the multi-scale highlights extricated from convolutional layers for associated assignments, and further work on the exhibition of DR evaluating in view of injury location and division. Second, while profound learning techniques are helpful in DR screening, there are a couple of profound learning strategies that furnish nearby picture quality appraisal with inertness viable with ongoing use, which is one of the most required augmentations at the essential DR screening level and will affect local area screening conveyance.

A reliable cell phone application based on considerable learning models was created to detect the existence of DR and other retinal abnormalities in fundus pictures. This study builds on previous research by first identifying the existence or absence of DR, then tolerating DR's presence and progressing through the stages associated with it. In this study, a considerable learning-based mobile phone application (for Android and iOS) is established to consistently distinguish the absence or presence of DR in its phases. Tensor stream is an open-source AI structure that takes you through the entire interaction. It has a far reaching biological system of instruments, libraries, and local area assets that permit scholastics to work on the best in class in AI and engineers to quickly plan and convey AI controlled items (Figure 1).

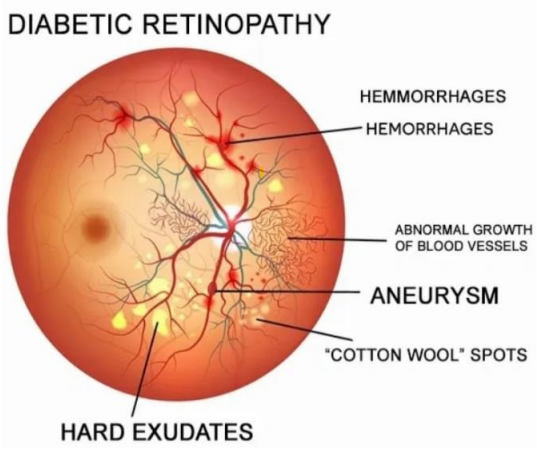

Figure 1: Illustrates the Diabetic Retinopathy Detection [14].

DR is partitioned into four phases: gentle, moderate, extreme, and duplicate. By using a cell phone and a point of convergence association, the program created here empowers a fundamental screening of DR in a down to earth and for the most part available way. The fundamental screening empowered by this program will be of extraordinary use to people who live in distant regions, since a speedy eye assessment might be done to allude clients to an ophthalmologist. The dataset for setting up the profound neuronal associations for distinguishing and orchestrating DR is introduced in region 2. The fragmented arrangement and testing of critical neuronal associations is shrouded in mystery. On cell phones, the construction of the profound neural organizations is displayed in segment. In district 5, the delivered mobile phone application's predictable taking care of velocities are shown, trailed by the end in segment.

II. DISCUSSION

A. Dataset

The ease with which a dataset may be prepared is important for establishing crucial brain relationships in order to observe the about 5 folds of DR counting from 0 stage, which suggests no DR. APTOS 2019 and EyePACS 16 datasets are twofold public district datasets that combine a massive number of photos of the general huge numbers of five times of DR. Both datasets are included in this study. The EyePACS collection contains 35126 retina pictures for both the left and right eyes. It defines the five degrees of DR, or authenticity levels 0 to 4, with name 0 denoting no DR, name 1 denoting sensitive DR, name 2 denoting moderate DR, name 3 denoting fantastic DR, and name 4 denoting copy DR. There are 25,810 0 DR (no DR) photographs detected in the collection, 2,443 sensitive DR images, 5,292 moderate DR images, 873 certifiable DR images, and 708 duplicated DR images. 10,000 images from the EyePACS dataset were used to orchestrate the crucial neuronal connection leads to 10 model retina images from the EyePACS dataset looking differently in comparison to the five instances of DR for no DR. The APTOS 2019 Blindness Detection dataset, like the EyePACS dataset, has 3662 retinal images containing a location with five times the DR. There are 1805 photos with no DR (mark 0), 370 photos with sensitive DR (name 1), 999 photos with facilitate DR (label 2), 193 photos with

amazing DR (mark 3), and 295 photos with copy DR (name 4) in this dataset.

B. Deep Neural Networks for DR Detection and Cataloguing

This segment looks at how two deep neural networks were created and tested in order to extract the five phases of DR pictures for two datasets. The trade learning procedure is used here since the preliminary dataset is frequently little for making profound neural organizations. Diabetic retinopathy (DR) is a retinal sickness that happens in diabetics. It started as an outcome of diabetes mellitus-instigated long haul retinal vascular harm. This infection is one of the most widely recognized reasons for visual impairment. As an outcome, diagnosing it almost immediately is basic. There are numerous medicines for this issue, however they consume a large chunk of the day and may require various eye assessments, including photocoagulation and vitrectomy.

Mild DR is a condition that affects the blood vessels in the eyes. In the event of Mild DR, the patient may be able to overcome the condition and recover completely. If this stage of the illness is not addressed, it will progress to Moderate DR. In the event of Moderate DR, blood vessel leakage might begin. If the condition progresses to the following stage, it becomes Severe and Proliferative DR, which may result in total visual loss. Profound learning (DL) is a part of AI methods that includes various levelled layers of non-direct handling stages for unaided highlights learning just as for ordering designs. DL is one PC supported clinical determination technique. DL applications to clinical picture investigation incorporate the characterization, division, discovery, recovery, and enlistment of the pictures. As of late, DL has been broadly utilized in DR identification and characterization. It can effectively gain proficiency with the elements of information in any event, when numerous heterogeneous sources incorporated. There are numerous DL-based techniques, for example, confined Boltzmann Machines, convolutional neural organizations (CNNs), auto encoder, and scanty coding. The presentation of these techniques increments when the quantity of preparing information increment because of the increment in the learned elements not at all like AI strategies. Likewise, DL techniques didn't need hand-made element extraction.

C. Designing the Networks

Important learning-based procedures for separating visual problems have recently been introduced, for example, 18, 19, and 20. A pre-arranged Inception-v3 model 21 is considered here for move learning, such as a recent open work reference. 1 The gigantic ImageNet dataset, which includes 1.2 million photos coordinated over 1000 distinct article features22, 23, inspired this arrangement. Convolutional layers as well as Langering affiliation are used in the Inception-v three model. Around the final entirely related layer, the layers of this pre-arranged model are employed. The final completely related layer is created using the dataset provided before. This work employs a two-adventure strategy, which incorporates two key neural interactions. Because of the EyePACS dataset, the initial step is to employ a deep neural connection to divide the retinal images into four groups: no DR, mild DR, moderate DR, as well as deep DR. The next step is to create a more detailed brain architecture that splits the last period of intense DR pictures into two phases: Critical DR and Proliferate DR. A retinal picture is then divided into one of five groups: "no DR," "fragile DR," "moderate DR," "degenerative DR," and "duplicate DR." It was discovered that this two-adventure mix produced the greatest accuracy for the iPAX dataset after testing several combinations of organizations. A two-adventure strategy is also investigated for the APTOS dataset. In any instance, given any combination of the two associations, the best mixture for this is one that isn't totally set in stone, one that demonstrates non-participation and the existence of DR is first examined in this mixture. Later DR instances are classified into four stages as well. The monstrous neural connection expected for the EyePACS dataset was ready, and retinal pictures from the EyePACS dataset partner with no diabetic retinopathy (name 0), sensitive diabetic retinopathy (name 1), moderate diabetic retinopathy (name 2), and fundamental diabetic retinopathy (name 3) were finished. Certifiable and replicated pictures from the iPAX assortment were utilized as a phase (names 3, and 4). The leftover 10% of the pictures from each class were utilized for testing, while 90% of the photos from each class were haphazardly chosen to be organized. The disarray associated with the essential attachment is shown in a framework. The total accuracy of crucial relationship for characterisation of the four stages of diabetic retinopathy was 88.4 percent, as shown in the graph. The second major neuronal development was also carried out in order to separate the exceptional DR into two stages: severe DR and multiply n. Specialist. 90% of photos from every classification were arbitrarily chosen for the course of action, with 786 photos as opposed to extreme DR and 637 photos rather than multiply DR, and the leftover 10% of photos, or 158 pictures, utilized for testing. They went. The construction of the disarray for the brief instant relationship for Severe DR and Multiply DR is shown. As displayed, the overall precision through the current second affiliation was viewed as 84.8 percent. The aftereffects of the essential association connected with the concentrated DR were sent to the subsidiary relationship to actually take a look at the general reaction or exactness. The disarranged association is displayed with a run of the mill exactness of 87.4% for the organized response that establishes the five phases of DR. Isolating the occurrence or nonattendance of diabetic retinopathy by characterizing all diabetic retinopathy stages (names 1, 2, 3, and 4) into one class and arranging diabetic retinopathy (mark 0) into one more in the most exhaustive neural development of the APTOS dataset is incorporated. The model was made by for arbitrary reasons picking 1,624 pictures with or without DR and 1,671 pictures with DR with 90% or no DR from the full 3,662 pictures. This activity was taken a stab at the leftover 10% of the pictures in the dataset, or 367 pictures. A disarranged cross segment connected with the essential affiliation is shown to choose the presence or non-presence of diabetic retinopathy. The going with get together had the choice of partitioning the DR pictures into four phases, haphazardly choosing 90% of the complete 1,857 DR pictures, rather than 370 sensitive pictures, 999 medium pictures, 193 genuine pictures and 295 different pictures Went. The assigned DR photos in the necessary association are given to the next relationship for assessment. The overall show depicts the disarray structure

of the last association zeroing in on DR picture demands in four stages. The general deception profiling for these two significant neuronal gatherings yielded 88.5 percent general precision. In this paper, the execution some portion of profound learning models which are functioning as applications on mobile phones is discussed.

C. Deep Learning Tools and Smartphone Software Tools

Following the planning of the deep learning model, they are done on cell phones to work endlessly as per the guidelines by our exam group. Strategies to accomplish continuous execution of deep learning models. Tensor Flow and Keras are used in Python to promote associations or deep learning models. Google's TensorFlow is a dataflow programming library. Tensor Flow models are easily incorporated into the Android improvement environment. Keras is a more significant level Python bundle that includes Tensor Flow as its backend as well as can be utilized to build Android applications. The utilization of TensorFlow Lite considers the production of profound learning models on cell phones. CoreML, which is a thing structure, was made by Apple. This permits the Keras model to be changed into a CoreML model, which can then be given to iOS gadgets. Android Studio is an incorporated advancement climate (IDE) for Android applications that utilizes the Java programming language. Xcode is an incorporated improvement climate (IDE) for iOS application advancement that utilizes the Objective-C or Swift programming dialects. All of the previously mentioned thing mechanical congregations are effectively accessible and are refreshed consistently by their individual associations.

D. IOS Smartphone Deployment

Keras saves the significant neural affiliation model as a HDF (Hierarchical Data Format.h5) record plan. The planning and association stacks of the model are protected as mathematical presentations in the HDF archive. Straightforwardly following stacking the.h5 keras model into Python, the CoreML structure changes over the Keras model to a CoreML model utilizing CoreML's mechanical congregations. The ". mlmodel" record is used to store the invigorated CoreML model. The change licenses you to name the responsibility as either an image or a frustrated bundle. In case an image is picked as the information decision, another decision is shown to decide the model's pre-dealing with limits. Given the combination of pre-dealing with accessible through different models, this is a critical choice since it permits a model to be utilized on crude pictures without performing pre-managing to every individual model. At long last, the CoreML model is shipped off an iOS contraption utilizing the Xcode IDE and Swift.

E. Deployment On Android Smartphones

The fundamental neural association model is underlying Keras utilizing the TensorFlow backend, and the TensorFlow model is eliminated from the Keras model. The data/yield utility blueprint is utilized to store the TensorFlow model as a Protocol Buffer (.pb) record after it has been disengaged. The pb record, similar to a HDF narrative, manages the model's course of action and affiliation stacks. From that point forward, the TensorFlow Lite focus individual is utilized to change over the. pb model into a. tflite model. This tflite model was made on Android telephones utilizing the Android Studio IDE and the Java box. TensorFlow Lite is utilized to make a get-together to deal with the model calculations, making it more straightforward for clients to zero in on imparting and testing the model. In reference, the strategies for the course of action of significant learning models for Android and iOS cell phones are displayed in more detail.

III. CONCLUSION

This work developed a cell phone application to provide a smart and generally accessible first-breeze through diabetic retinopathy eye inspection by progressively recording and organizing camera photos. The calculation utilizes two profound neural associations: one to portray diabetic retinopathy and its three phases, and the other to part the last stage into two stages for an aggregate of five stages, with zero connoting diabetes retinopathy. It has been shown the way in which these pre-arranged associations might be changed over into a versatile application that chips away at both Android and iOS gadgets. The study's ongoing application enables for conducting first-breeze eye exams in facilities or remote places where fundus cameras and ophthalmologists are few, such as in various third-world countries. In terms of future compilation, the Android application may have a storage capacity of more than 1 MB, which may be reduced to less than 1 MB. Additionally, some Android versions may easily support the applications. It's straightforward to send the report as a message since it's shown on the screen.

REFERENCES

[1] N. Tsiknakis et al., “Deep learning for diabetic retinopathy detection and classification based on fundus images: A review,” Computers in Biology and Medicine. 2021, doi: 10.1016/j.compbiomed.2021.104599.

[2] P. Costa, A. Galdran, A. Smailagic, and A. Campilho, “A Weakly-Supervised Framework for Interpretable Diabetic Retinopathy Detection on Retinal Images,” IEEE Access, 2018, doi: 10.1109/ACCESS.2018.2816003.

[3] G. Kalyani, B. Janakiramaiah, A. Karuna, and L. V. N. Prasad, “Diabetic retinopathy detection and classification using capsule networks,” Complex Intell. Syst., 2021, doi: 10.1007/s40747-021-00318-9.

[4] Revathy R, “Diabetic Retinopathy Detection using Machine Learning,” Int. J. Eng. Res., 2020, doi: 10.17577/ijertv9is060170.

[5] S. Kumar, A. Adarsh, B. Kumar, and A. K. Singh, “An automated early diabetic retinopathy detection through improved blood vessel and optic disc segmentation,” Opt. Laser Technol., 2020, doi: 10.1016/j.optlastec.2019.105815.

[6] D. J. Hemanth, O. Deperlioglu, and U. Kose, “An enhanced diabetic retinopathy detection and classification approach using deep convolutional neural network,” Neural Comput. Appl., 2020, doi: 10.1007/s00521-018-03974-0.

[7] M. H. Sarhan, S. Albarqouni, M. Yigitsoy, N. Navab, and E. Abouzar, “Microaneurysms segmentation and diabetic retinopathy detection by learning discriminative representations,” IET Image Process., 2020, doi: 10.1049/iet-ipr.2019.0804.

[8] M. P. Pai, M. H. Wilcox, S. Chitra, and P. C. McGovern, “Safety and efficacy of omadacycline by BMI categories and diabetes history in two Phase III randomized studies of patients with acute bacterial skin and skin structure

infections," J. Antimicrob. Chemother., 2021, doi: 10.1093/jac/dkaa558.

[9] J. Zhang et al., "Association between family history risk categories and prevalence of diabetes in chinese population," PLoS One, 2015, doi: 10.1371/journal.pone.0117044.

[10] J. A. Campbell, G. C. Farmer, S. Nguyen-Rodriguez, R. Walker, and L. Egede, "Relationship between individual categories of adverse childhood experience and diabetes in adulthood in a sample of US adults: Does it differ by gender?," J. Diabetes Complications, 2018, doi: 10.1016/j.jdiacomp.2017.11.005.

[11] D. Pruthviraja, B. C. Anil, and C. N. Sowmyarani, "Efficient local cloud-based solution for diabetic retinopathy detection," Int. J. Web-Based Learn. Teach. Technol., 2021, doi: 10.4018/IJWLTT.20210501.oa3.

[12] P. Costa and A. Campilho, "Convolutional bag of words for diabetic retinopathy detection from eye fundus images," IPSJ Trans. Comput. Vis. Appl., 2017, doi: 10.1186/s41074-017-0023-6.

[13] R. E. Hacisoftaoglu, M. Karakaya, and A. B. Sallam, "Deep learning frameworks for diabetic retinopathy detection with smartphone-based retinal imaging systems," Pattern Recognit. Lett., 2020, doi: 10.1016/j.patrec.2020.04.009.

[14] DEV.TO, "Diabetic Retinopathy Detection." https://www.google.com/imgres?imgurl=https%3A%2F%2Fres.cloudinary.com%2Fpracticaldev%2Fimage%2Ffetch%2Fs--joAgg5WN--%2Fc_limit%252Cf_auto%252Cfl_progressive%252Cq_auto%252Cw_880%2Fhttps%3A%2F%2Fuser-images.githubusercontent.com%2F30235603%2F106426729-83b9 (accessed Feb. 15, 2022).