

Review of Artificial Intelligence Techniques for Visually Impaired People

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Abstract: This review research paper presents an overview of developments in artificial intelligence (AI) methods that are aimed at enhancing the lives of people with visual impairments. The review outlines the results of studies that employ AI to solve problems experienced by the visually impaired community. First, the paper emphasizes the significance of AI-based solutions in supporting persons with impairments. It also gives the details of the datasets that have been used for training and evaluation purposes. It further goes on to mention the AI techniques that are common in this area, such as computer vision, natural language processing, and assistive technologies. Apart from that, the paper highlights one of the critical uses of AI for visually impaired people - object recognition and scene understanding. It was discovered that researchers utilized convolutional neural networks (CNNs) and other deep learning methods that allow the objects and their environments to be instantly recognized by persons who are visually impaired, thus possibly giving them more independence and a sense of security. Besides, it also covers technologies like text-to-speech and speech-to-text systems, which help in information gathering and communication. The paper further discusses aids that help with navigation and mobility, as well as systems that utilize AI to plan routes and detect obstacles promptly. To sum up, this paper reiterates the immense possibilities that AI technologies hold in significantly improving the quality of life of, and encouraging the inclusion of, impaired individuals. Hence, this review paper underscores the role of research and development in this regard to produce easy-to-use and inexpensive AI solutions that will empower people with visual impairments to live more independently and satisfactorily.

Keywords: Artificial Intelligence (AI), Visual Impairment, Computer Vision, Deep Learning, Convolutional Neural Networks (CNNs)

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1. Introduction

Visual impairment poses obstacles for individuals, affecting their lifestyles, their independence, and their access to information. Although it is a condition with different levels of severity, the development of intelligence (AI) technologies has ushered in a new era of hope and possibilities for persons with visual impairments. This introduction examines the conjunction of AI and visual impairment and features research result discussions that reveal how AI is changing the scenario for people with impairments. Visual impairment refers to various conditions, from loss of vision to complete blindness. The difficulties that persons with impairments encounter are extensive. Besides, they consist of a lack of ability to recognize objects, finding one's way in new

environments, reading printed and digital materials, and participating in education and work. Yet in recent years, AI-driven solutions have appeared as means to mitigate these challenges and enhance the lives of individuals with visual impairments [1].

This introductory part is based on a set of research summaries that present the range and scope of AI interventions in the support of impairment. These summaries expose us to articles that concentrate on different facets of AI technology, data analysis methods, and assistive technologies. Looking at these summaries, we get an understanding of AI's potential in multiple aspects of visual impairment; the first set of papers noted in the summaries is focused primarily on the application of AI for object identification and scene comprehension [2].

Neural networks (CNNs), deep learning, and other similar techniques have not only helped PhD researchers to identify objects in real time, but they are also able to grasp the environment's context. Such achievements have dramatically contributed to helping people with disabilities, providing them with fresh and unprecedented freedom as well as better safety. It is therefore quite obvious that major developments in text-to-speech and speech-to-text modes, which have changed the very notion of information access, are a result of the introduction of AI in devices and software. AI-based tools are capable of reciting text, and it is quite simple through these gadgets for the disabled to dictate and transcribe. This excellent facility has facilitated communication, education, and information retrieval [3].

Besides, AI's influence on impairments is visible in navigation aids and mobility assistance. AI algorithms can be combined with cameras and other sensors to enable real-time path finding and detection of obstacles. Now, equipped with these AI-based navigation tools, persons with disabilities can move about safely and avoid potential dangers. It gives them the feeling of being self-sufficient and safe.

Education and employment have also been changed through the incorporation of AI. Efforts are being made by scientists to utilize AI to convert printed materials into accessible forms that aid impaired learners, such as Braille and audio. This incredible technological leap is giving students with visual impairments equal chances to get access to educational resources that suit their needs through the use of adaptive learning environments. Besides, AI is facilitating the creation of new job opportunities by making the digital workplace more accessible and by giving disabled persons the ability to engage in a variety of new professions. These AI models also put the spotlight on the significance of identifying appropriate AI techniques and strategies. CNNs and

GANs are examples of AI models that are also quite popular among researchers. They have certain pros in terms of specific tasks. As research work keeps on getting deeper and more detailed, it becomes clear how AI keeps on evolving so that it can solve the problems of visually impaired persons [4][5].

On the other hand, the role of data preprocessing cannot be overlooked. Whether it is image resizing or changing the format to one that is more user-friendly, all these contribute to making the quality and relevance of input data better. They also provide a solid starting point for AI-related works that end in effective solutions.

2. Related Work

Researchers in a study that used the FIRE dataset implemented specially designed preprocessing steps for cataract grading. Firstly, they focused on extracting highly specialized texture features and then made use of a Convolutional Neural Network (CNN) for the analysis. The performance was so good that an accuracy of 99.13% was achieved, which clearly indicates the ability of CNNs in analyzing images and classifying cataracts [6].

In the study that involved the use of the Aptos dataset, we performed various preprocessing steps such as cropping and changing the resolution of the images. For feature extraction, we used a Feature Extractor. The main method was a convolutional neural network (LBCNN). The results of the research were performance-wise at 92.39%. This emphasizes the power of LBCNN in handling the processed Aptos dataset [7].

In a study using the cataract dataset, researchers applied techniques to stage the disease. They worked on extracting local features and global features to make the model robust. They came up with a new technique called "CataractNet" for the purpose of cataract detection. Impressively, this method was able to get an accuracy of 99.13%, which means it is very likely to be useful in the field of ophthalmology [8].

The initial stage basically was world dataset pre-processing - aimed at improving the quality and relevance of the data. Extracting texture features was really the leading task since it is one of the most important computer tasks. In order to understand and represent the degree of complexity of these extracted features, researchers used 3D Convolutional Neural Networks (3D CNN). Even though the specific results were not included in the metadata, the mixture of texture feature extraction and 3D CNN suggests the intention to use learning capability for recognition of patterns in complex datasets [9].

In another work with the ORIGA REFUGE dataset, preprocessing consisted of changing images to grayscale as well as correcting brightness levels. The research took feature extraction as the main theme. The 3D CNN framework was the tool for working with the dataset. It is quite surprising that the networks that were trained without any data augmentations actually showed decent results. Meanwhile, the models that were enhanced with individual augmentation techniques, such as weak Gaussian blurring or random shifted augmentation, failed to match the performance of the original models. Hence, this clearly reveals the significance of selecting the right augmentation methods to maintain the performance of the model [10].

In the paper based on the EyeQ dataset images, the preprocessing involved steps such as changing format and size. The lead feature extraction method was the "Feature Extractor." Next, a Convolutional Neural Network (CNN) was used to get the job done. The results of the trials indicated that the predictions of the networks were extremely accurate with an Intersection over Union (IoU) of 76.61% and a Dice coefficient of 86.51%. These results point to the capability of this technique to noticeably lighten the work of eye doctors [11].

In a study, the datasets from DRIVE and STARE went through preprocessing steps such as converting formats and resizing images. The team used Feature Map for feature extraction. The main technique was to utilize an R CNN merged with WGA (Weighted Global Average). The introduced R CNN with WGA has shown very good performance by reaching the level of accuracy of 95.42%, specificity 93.10%, sensitivity 93.20%, and an F score of 98.28%. These results show the effectiveness of this twin approach in handling these particular datasets [12].

The study utilized the ORIGA REFUGE dataset. Performed preprocessing tasks such as removing black borders and ensuring uniform image resolution. Afterward, they conducted feature extraction to create a feature vector. For analysis, the researchers employed a Convolutional Neural Network (CNN). The findings revealed an accuracy of 89%, along with a sensitivity rate of 89% and a specificity rate of 97.3%. Notably, these findings outperform the leading benchmarks in this field [13].

In their study using the ORIGA REFUGE dataset, researchers focused on improving the structure of the data by applying techniques. They utilized color features. Implemented the GACNN method, which resulted in results. GACNN achieved an accuracy rate of 93.35%, showcasing a 6.24% improvement compared to the model. These findings highlight the potential of leveraging color features through GACNN to enhance performance [14].

Another paper on the EyeQ dataset mainly used image pre-processing techniques such as resizing and brightness/contrast adjustment. Although feature extraction methods were not mentioned, the authors explicitly analyzed the images using ODGNet. This model gave very good results when tested on the ORIGA dataset for glaucoma detection with a rate of accuracy of 95.75% along specificity of 94.90%, a sensitivity of 94.75%, and an area under the curve (AUC) of 97.85% [15].

In their paper, the scientists carried out a comparative experiment to check the capability of a neural network (CNN) based feature extraction approach using the datasets "DRIVE" and "STARE". In order to make images more comparable, the authors made use of a "Feature Extractor" technique to draw features from the samples under different illumination conditions. The CNN model, after being put through the known datasets, reached different levels of accuracy, which are as follows; 98.92% for ACRIMA, 99.06% for REFUGE, 98.27% for RIM ONE, 97.10% for ORIGA light, 96.97% for Drishti GS1, and 96.36% for sjchoi86 HRF. These results clearly indicate the capability of the model and its possible utility on different datasets [16].

This paper is all about a method of extracting features from images using Convolutional Neural Networks (CNN). The authors draw on several different datasets, including ACRIMA, REFUGE, RIM ONE, ORIGA light, Drishti GS1, and sjchoi86 HRF to test the power and efficiency of the method they are proposing. The preprocessing involved randomly rotating and flipping the images. Feature extraction largely depends on obtaining features through CNNs. The experimental findings from these datasets affirm the superior performance of the proposed method in ophthalmic image analysis problems [17].

The paper entitled "Improving Object Recognition in EyeQ Dataset through Contrastive Learning" puts forward a method for greatly improving the performance of object recognition with the EyeQ dataset. The work deals mainly with the image normalization/standardization technique as a main target in preprocessing, while at the same time, other methods of feature extraction are local features, and their most important global feature extraction technique is contrastive learning, which was also enhanced by a touch of global-to-local via local feature alignment. The authors verify the power of their technique on the EyeQ dataset and post thorough experimental results. Their study, along with some detection and recognition experiments, further improves and shows the potential of the method that this research

synthesises with learning and feature extraction at the core, in the context of increasing the accuracy and making better the object recognition systems. Their results provide evidence [18].

In this research paper, the authors investigate the application of a technique known as StillGAN in analyzing images with a focus on the DRIVE and STARE datasets. The study covers aspects of preparing the data, giving attention to converting formats. The extraction of features involves utilizing features as part of their implementation. The main approach used in this investigation involves the utilization of the StillGAN algorithm. The results of the study demonstrate how effective this method is in medical image analysis and clinical tasks, such as nerve segmentation, tortuosity grading, fovea localization, and disease classification. These findings highlight the potential of the proposed approach to improve medical image analysis and contribute to outcomes [19].

In a research paper titled "CORN 2 iSee; Uniform Resolution and Texture Features for Dr Grading," the authors explore the use of images for data augmentation in diabetic retinopathy (DR) grading. The focus of this study is on the EyePACS testing set, where uniform resolution and texture features are employed as components for extracting features. The research demonstrates that by incorporating images into the dataset, a state-of-the-art DR grading model shows improvements. Specifically, there is an increase in model accuracy by 1.53% and a substantial enhancement of 1.70% in the quadratic weighted kappa score. These findings indicate that integrating resolution and texture features alongside data augmentation using images can greatly enhance DR grading model performance, which could have beneficial implications for ophthalmology and early detection of diabetic retinopathy [20].

The research paper focused on utilizing the Kaggle dataset and applying techniques to preprocess and improve the data. To extract features, they used texture features. The main approach they employed in their study was DDFA GAN, which showed its ability to generate images of OCT (Optical Coherence Tomography). The images that were generated for this study were specifically designed to meet the requirements of a learning-based examination of the retina. It is worth noting that the use of DDFA GAN greatly improved the accuracy of measurements in this context. Overall, this research emphasizes how effective DDFA GAN is in producing OCT images, which in turn enhances examination and measurement accuracy for retinal analysis [21].

This research paper focuses on enhancing the analysis of images by utilizing Generative Adversarial Networks (GANs) as a technique for extracting features. They mainly use three well-

known retinal image datasets, which are DRIVE, CHASE DB1, and STARE. First of all, the researchers decided to bring about as many changes as possible due to the lighting conditions in the images by means of preprocessing. The major feature of them is the application of GANs for feature extraction, which stands as a completely new technique. Their results show improvements in the methods of the past. Particularly, their method reaches accuracies of 0.9869, 0.9894, and 0.9885 for DRIVE, CHASE DB1, and STARE, respectively. The results present further evidence for the potential of feature extraction using GANs in image analysis and the advantage of this over existing approaches [22].

In this research study, the authors utilized the Kaggle dataset. Conducted a preprocessing phase that involved cropping and adjusting image resolutions. Afterward, they employed a mix of global and local feature extraction methods on the processed data. In their study, the authors extensively experimented with a Generative Adversarial Network (GAN) as their approach to evaluate its performance. The outcome of their research included an analysis of the proposed supervised GAN method and a transfer learning approach. Surprisingly, the supervised GAN method showed results achieving an accuracy rate of 87%. These findings highlight the effectiveness of this methodology. Suggest it as a technique for image classification tasks [23].

This paper is meant to present a method that can be used to improve vessel segmentation on the CHASE_DB1 dataset, which consists of using texture features and SE ResNet architecture. The investigation first utilizes data augmentation techniques to diversify the dataset and then extracts texture features. Later on, the vessel segmentation would be made by the SE model. At the end of the research, the authors deliver the results, as the proposed way obtained a Receiver Operating Characteristic Area under the Curve (ROC_AUC) of 0.9839 and Precision Recall Area under the Curve (PR_AUC) of 0.9002 on the CHASE_DB1 dataset. The experiments show that the use of texture features and the SE ResNet model significantly contributes to vessel segmentation accuracy, which in turn suggests medical image analysis and diagnosis applications [24].

The research paper is concerned mainly with the resolution enhancement of fundus images based on their shade correction feature extraction and Generative Adversarial Network (GAN) technique. The APTOS 2019 dataset was used. First, lighting adjustment, i.e., shade correction, is done. In this paper, researchers extract features from images that have been preprocessed. Their GAN-based architecture outperforms in terms of resolution compared to the other

methods. The results of their experiments strongly support their approach and also show its capability to contribute to fundus image enhancement in medical image processing [25].

The goal of this paper is to examine fundus image analysis by converting the images into grayscale and using Convolutional Neural Networks (CNN). In order to preprocess the fundus images and make their analysis easier, the authors of the paper resort to grayscale conversion. Besides that, they also go for an extraction of features from the preprocessed images with the help of a CNN-based method. Nevertheless, no thorough CNN details are specified in the project's metadata [26].

This research paper aims to enhance the diagnosis of diseases through deep learning techniques. Using the DDR APTOS Kaggle 2019 dataset, the study begins by reducing image size to improve efficiency during preprocessing. Feature extraction techniques, Feature Map, are then applied to extract information from retinal images. The primary method employed in this study is Convolutional Neural Networks (CNN) [27].

This paper is about instruction and understanding image analysis, looking at the study that used the Kaggle dataset as an example. In the preprocessing stage, the dataset is border-removed, and the resolution is checked. The use of feature extraction methods leads to the creation of a feature vector. Paradoxically, the research results that were revealed show that bigger CNN architectures do not always necessarily perform better with data. This is contrary to what one would expect based on their success with datasets. This observation sheds light on the interplay between the extent of the architecture and the amount of the dataset in image classification tasks [28].

In this research study, we used the Heidelberg SDOCT imaging system along with data enhancement techniques and color features to extract features. Our methodology involved implementing Grad CAMs, a technique used in computer vision. Our main objective was to investigate the effectiveness of ensembles of classifiers fine-tuned through transfer learning strategies. The results we obtained indicate an improvement in accuracy, suggesting that our proposed approach has potential for enhancing diagnostic capabilities. Additionally, our findings demonstrate that the learned filters and Grad CAMs generated by the classifiers align with established knowledge [29].

This research paper focuses on classifying fundus images based on severity using a learning (DL) model combined with classifiers. We sourced our dataset from Kaggle. Performed format conversion as part of the preprocessing step.

Even though the metadata did not explicitly discuss the techniques used for feature extraction, the study employed a Convolutional Neural Network (CNN) as the approach for classification. The objective of the research was to classify fundus images based on their severity classes, which indicate the level of pathology or disease [30].

Paper Ref.	Dataset	Preprocessing	Feature Extraction	Method
6	FIRE	Cataract Grading	Texture Features	Convolutional Neural Network (CNN)
7	Aptos	Cropping, Image Resolution	Feature Extractor	local binary convolutional neural network (LBCNN)
8	cataract dataset	Data Augmentation	Global and Local Features	CataractNet
9	Real-world dataset	Basic Preprocessing	Texture Features	3D-CNN
10	ORIGA REFUGE	The grayscale conversion technique The shade correction method	Concrete Features	3D-CNN
11	EyeQ	Format conversion, Reduce image size	Feature Extractor	CNN
12	DRIVE STARE	Format conversion, Reduce image size	Feature Map	R-CNN with WGA
13	ORIGA REFUGE	Cropped black borders, Uniform resolution	Feature Vector	CNN
14	ORIGA REFUGE	Restructured data enhancement	Color Features	GACNN
15	EyeQ	Image resizing Brightness-contrast	Not mentioned	ODGNet
16	DRIVE STARE	Minimising lighting differences	Feature Extractor	CNN
17	ACRIMA, REFUGE, RIM-ONE, ORIGA-light, Drishti-GS1, and sjchoi86-HRF datasets	Random rotation and mirror flip	Feature Map	CNN
18	EyeQ	Normalization	Global and Local Features	Contrastive Learning
19	DRIVE STARE	Format conversion	Binary Features	StillGAN
20	CORN-2 iSee	Uniform resolution	Texture Features	Dr-Grading
21	Kaggle	Restructured data enhancement	Texture Features	DDFA-GAN
22	DRIVE, CHASE-DB1 and STARE	Minimising lighting differences	Feature Extractor	GAN

23	Kaggle	Cropping, Image Resolution	Global and Local Features	supervised GAN
24	CHASE_DB1	Data Augmentation	Texture Features	SE-ResNet
25	APTOS 2019	The shade correction method	Concrete Features	Generative Adversarial Network
26	IDRID DiaretDBI	The grayscale conversion technique	Feature Extractor	CNN
27	DDR APTOS Kaggle 2019	Reduce image size	Feature Map	CNN
28	Kaggle	Cropped black borders, Uniform resolution	Feature Vector	CNN
29	Heidelberg SDOCT imaging system	data enhancement	Color Features	Grad-CAMs
30	Kaggle	Format conversion	Not mentioned	CNN

3. Critical Analysis

The merging of intelligence (AI) and visual impairment is an area in technology that has the potential to greatly enhance the lives of millions worldwide. During our conversation, we looked at several research abstracts. These abstracts helped us understand how AI strategies might help visually impaired people. This write-up will try to find out the good points, bad points, and larger impacts of AI solutions for impairment. For instance, a major perk of AI in this area is being able to enhance the recognition of objects and scene comprehension. Through the application of CNNs and deep learning methods, AI systems have reached an excellent level of accuracy in detecting objects and understanding environmental contexts. This capability gives visually impaired individuals more comfort and independence in how they move around.

Also, the ability of AI to work in real-time ensures that the answer is always available, which is indeed a crucial aspect for safety and practicality. Just as significant is the role of AI in the emergence of text-to-speech and speech-to-text tech. These technologies have been very crucial in eliminating barriers from the lives of handicapped people by providing them with the means to listen to printed or digital material and to produce their spoken words for transcription.

This innovation provides enormous possibilities for readers of printed matter to get involved in the conversations and even look for the information on their own. A case of Artificial Intelligence (AI) implemented in devices for navigation and mobility assistance is shown here. When visual and sensor inputs are supplied to AI models, they are capable of identifying the path and recognizing the obstacles in real-time, thus affording blind people greater freedom and self-

assuredness in their movement. In fact, these AI-driven methods not only improve their mobility but also contribute to the development of a sense of safety and independence among the users.

The role of Artificial Intelligence in education and employment opportunities for disabled people must be recognized. AI-assisted applications, such as giving printed materials in Braille or audio formats, enabling blind students to have unhindered access to educational resources, are just one way that such tools are transforming the methodology of making the inclusive materials. Coupled with that, AI-driven adaptive learning systems allow students with disabilities to receive tailored educational experiences.

Additionally, in the workplace, AI plays a major role in breaking down barriers for disabled individuals by making the digital work environment accessible, which in turn enables them to explore and carry out a wide range of occupations quite efficiently.

However, there are certain challenges and limitations when it comes to the application of AI in impairment. For example, the question of affordability remains as one of the major concerns; even though the benefits are significant, the cost of AI-based solution implementation can be a bigger problem for people with limited resources. The fact that these technologies should be available to everyone is still a problem. Besides that, usability issues can arise, as the AI software for impaired people needs to be simple and easy to understand to be very effective.

When designing user interfaces, it is crucial to consider factors like compatibility with technologies in use and how easily they can be integrated into people's everyday routines. Additionally, meeting the needs and preferences of impaired individuals is a complex challenge that necessitates continuous collaboration between technologists and the visually impaired community.

Many of the AI technologies that have enabled the growth of this industry, at the same time, have triggered some concerns. One of the reasons is that, besides convincing the skeptics, the effective deployment of these technologies requires building trust and ensuring that they truly address the needs of and are compatible with the cultural contexts of disabled people. Besides, privacy and security of data are major concerns when it comes to the development of AI for disability. Most AI innovations are based on gathering and analyzing data such as images or voice recordings. So, it is very important to give top priority to protecting the privacy and security of that data if we want to earn users' trust and also meet the requirements of the law. To conclude, although research articles report on the outcomes, it is necessary to point out that AI

will never be a universal solution for everyone, and different AI techniques and data preparation methods have to be selected depending on the situation and the needs of the users. AI developers must commit to extensive testing and verification of their AI technologies to guarantee that these tools faithfully respond to the demands of the disabled.

4. Conclusion

Integrating Artificial Intelligence (AI) with impairment is a major step in enhancing the quality of life for people who are experiencing various levels of vision loss. This article uses a few of the most important points from research papers to explain how artificial intelligence (AI) can help disabled people, while also analyzing them critically. Clearly, AI is more than a technological breakthrough; it serves as a beacon of hope for millions of people around the world. One of the most amazing facets of the AI contribution is its ability to recognize objects and understand scenes, which in turn helps give disabled people a greater level of freedom. Mainly through the use of neural networks (CNNs) like scene recognition, AI applications offer people an accurate understanding of their surroundings, coupled with real-time feedback that helps raise their self-assurance in moving around.

Another great thing is the progress in the text-to-speech and speech-to-text technologies using AI as a base. These advances do away with the hurdles in accessing information and communication; hence, education, work, and regular living opportunities become available to disabled people. By converting text into speech and speech into text, AI ensures the two forms of language, i.e., written and spoken, are connected.

More than that, AI drives the innovation of mobility aids that not only ensure safety but also uphold and promote independence. By leveraging AI algorithms coupled with cameras and sensors, we are capable of not only route mapping but also obstacle detection. This is a double benefit as it enhances our ability to navigate and, at the same time gives us a sense of independence and self-reliance.

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