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Potential Benefits and Opportunities of AI-Enabled Software Programs for Opticians: A study in Türkiye

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ABSTRACT

The utilization of deep learning models and artificial intelligence (AI) in optical projects has garnered significant international attention in recent years. The latest AI technology is believed to revolve around deep learning models. In practical terms, deep learning algorithms can be employed to detect, measure, and describe clinical characteristics of ophthalmic optics. Advances in optics, scientific foundations, and technological applications have rendered it a versatile basis for problem-solving in manufacturing, basic research, and engineering applications, including quality control, non-destructive testing, experimental mechanics, and biomedicine. Deep learning, a branch of machine learning, has recently emerged as a potent tool for addressing challenges by learning from data. This emergency is largely attributed to the availability of extensive datasets, advanced computing power, rapid data storage, and proprietary deep neural network training techniques. By adding features to existing interfaces of the Medula Optical Provision System, ÜTS (Product Tracking System), and other assistive optical package programs used in Türkiye, the AI-enabled enhancement of research on eye health and access to detailed information about the supplied products will effectively increase the service quality in optical stores. Through artificial intelligence, it will also aid in problem-solving in optic and ophthalmic areas.

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1. Introduction

Opticians, like numerous other healthcare professions, require AI-enabled software programs for their professional development. Applying artificial intelligence in ophthalmology programs can be advantageous in several ways, including [1]. Artificial intelligence is a powerful tool that can improve opticians' performance and efficiency in various aspects of their work. Benefits of using AI for opticians, ophthalmologists, and patients include [2]: By analyzing eye scans taken during a routine visit, artificial intelligence can assist ophthalmologists in diagnosing eye diseases and conditions. For example, AI can identify disease by an eye scan or detecting signs of blood vessel damage or inflammation [3, 4]. Artificial intelligence can assist ophthalmologists in crafting individualized prescriptions for contact lenses and eyeglasses for their patients. This is achieved by considering factors such as their patients' visual acuity, preferences, lifestyle, and facial features. Opticians can design new eyeglasses, assemble montage eyeglasses, and recommend preferred contact lenses to address these identified needs. For example, AI can recommend optimal lens designs, materials, coatings, and frames based on data collected from online surveys or smart devices. AI can help opticians optimize their workflow and inventory management using digital platforms and cloud-based solutions [5, 6]. For example, AI can automate tasks such as scheduling appointments, ordering supplies, tracking shipments, and generating invoices [7]. Using online courses and resources, artificial intelligence can help opticians learn new skills and update their knowledge. For example, artificial intelligence can provide personalized feedback and recommendations based on the opticians' performance and

learning goals. Artificial intelligence is transforming the field of optics by providing new opportunities and challenges for opticians. By adopting artificial intelligence solutions, opticians can increase their service quality, customer satisfaction, productivity, and profitability [8]. In this study, we report an overview of AI-enabled opticianry software benefits in Türkiye. We inform about combining AI and optic programs by enriching, strengthening, and improving these programs with databases accessible. While the service provided by opticians and scientific opticians to consumers of vision equipment is recorded electronically with Medula, ÜTS, and other auxiliary optical package programs, with deep learning, the descriptive academic information needed in the optics sector and eye health service is sought by opticians and scientific opticians. So, we can effectively increase the quality of service and the number of qualified opticians and scientific opticians, by AI-based optical system technology.

2. Method

The advantage of opticians and scientific opticians in using artificial intelligence is transforming various fields and industries, including optometry. Opticians, professionals who design and distribute corrective lenses and contact lenses for patients, can benefit from the use of artificial intelligence in several ways. Here are some benefits of using AI for opticians, ophthalmologists, and patients [9]:

2.1. Improved Accuracy and Efficiency

AI can help opticians analyze patients' visual acuity, refractive error, and eye health more accurately and efficiently. For example, AI can use digital images or scans to detect and diagnose eye diseases such as glaucoma, cataracts, and diabetic retinopathy. The work of ophthalmologists and patients can be facilitated [10].

2.2. Enhanced Opticianry Service and Vision Equipment Consumer Satisfaction

AI can help opticians improve customer service and satisfaction by providing more convenient and accessible options for patients. For example, artificial intelligence can enable online consultations and the ordering of lenses or contact lenses through chatbots or virtual assistants. AI can also create realistic simulations of how different frames or colors will appear on a patient's face using augmented reality (AR) or virtual reality (VR) technologies [11].

2.3. Increased Competitiveness and Profitability

AI can help opticians increase their competitiveness and profitability by reducing costs and increasing revenues. For example, AI can optimize inventory management and the supply chain by predicting demand and minimizing waste. AI can also generate insights and feedback from customer data to improve marketing strategies and loyalty programs [12]. Opticians can evaluate the power of artificial intelligence to improve their performance, quality, and value in optics. By adopting AI solutions, opticians can grow their business while providing better care to their patients [13, 14]. Due to its application in optics, it is growing and attracting great attention. Deep learning in optics is a type of "data-driven" technique as opposed to traditional "physics-based" approaches, and many alternatives yield better results for many of the toughest challenges in this industry. Deep learning is a subset of machine learning that uses specific algorithms that allow machines to automatically find patterns in large amounts of historical data and use these patterns to make predictions or intelligent face-to-face decisions [15, 16]. McCulloch and Pitts' research into the artificial neural network, created from a simplified mathematical model of biological neurons, is where machine learning and deep learning first emerged [17]. Traditionally, classification problems have been solved using CNNs (convolutional neural networks). Typical CNNs segregate geographical information and generate non-spatial outcomes due to the presence a parameter-rich, connected layer at the network's conclusion. For many of the image processing tasks we encountered earlier in the "Image Processing in Optical Metrology" section, the network must provide a full resolution output that is as large as or even larger than the input, known as hard estimation (as opposed to one object per image class) [18].For this convolutional network models that do not have fully connected layers, take inputs of any size, operate with regression loss, and give an output of the corresponding size should be used [19, 20]. Figure 1 shows standard CNN architecture for applications involving image categorization: a) The input layer, convolutional layers, connected layers, and output estimation make up the traditional CNN architecture for image classification problems b) Convolutional processing c) The joining process.

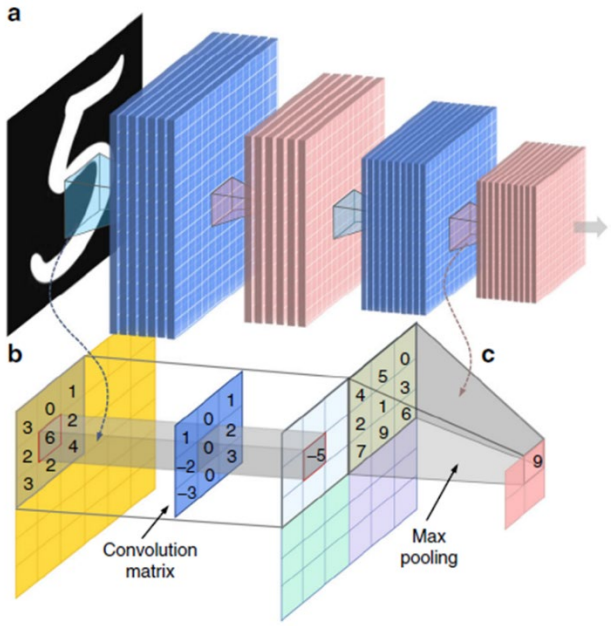

Figure 1. Standard CNN architecture for applications involving image categorization

3. Discussion

Optician refers to the natural person authorized to practice opticianry under the Turkish Law Regarding Opticians Numbered 5193. A degree in Opticianry Vocational School is now a requirement for opening Opticianry establishments. As it is known, Scientific Opticianry was defined by Law No. 3958 in 1940 and evolved into Opticianry with Law No. 5193 in 2004. The Opticianry associate degree program was first established in 1992 at Cumhuriyet University in Sivas, Turkey. To meet the increasing demand and developments in the sector, Opticianry programs have been opened at many universities. To carry out the profession of an optician which involves selling many lenses and contact lenses according to prescription, selling frames for eyeglasses according to lenses and face shapes, and assembling spectacles, it must graduate from at least an associate degree vocational school in opticianry. Opticians are healthcare professionals who sell eyeglasses and frames, contact lenses, and similar optical products with a prescription, prepare and assemble eyeglasses and frames in line with prescriptions, and deal with their adjustment and repair. Opticians can also repair damaged eyeglass frames. In addition, they can extend the life of the glasses by performing regular maintenance. They describe the product features that can help the person choose prescription of optical glasses or contact lenses suitable for their eyes. Making appropriate choices for the environment in which vision devices will be used, considering age and other factors, increases a person's visual quality. Opticians utilize various software programs as part of their profession. In addition to the Medula Optical Application Web Services, where the responsible managers enter e-prescriptions and have their eyeglasses and frame codes read, additional package programs are also used in the institution. In addition, there are opticians who use Microsoft Excel instead of additional optical programs. MEDULA, which means health network, is one of the most important informatics projects carried out by the SGK, Turkish Social Security Institution (SSI). It is an electronic information system implemented and operated by Ministry of Health. It is used to monitor and store the transactions related to healthcare services in the digital environment, to perform the transactions faster and safer, and to determine whether the person applying to the institution has the right to benefit from the materials on the institution's information processing systems. Patients whose health care costs are covered by the institution and for whom medical aids to assist vision are prescribed in line with the institution's legislation are patients. Based on the patient information entered, some checks and inquiries regarding meeting the prescription content are made, and the filled prescriptions are invoiced to the institution. Through the Medula Optical Application, various transactions are conducted for consumers of vision equipment and eyeglasses users, such as e-prescription entry transactions, end-of-term transactions, paperwork, and invoice transactions. It is possible to access the diopter information of eyeglass users and the duration information of their frame-glass rights. Technical opticians and opticians can easily manage their patients' eyeglasses and contact lens needs within the scope of SGK through the Medula Optical Provision System. With the Medula web service, the ophtalmic lenses or contact lens needs of the patients are determined, and a payment request is sent to the SGK. Registered e-prescriptions can be stored electronically. These processes make it easier to track service records of visual equipment consumers by scientific opticians and opticians. With the latest updates to this system, the workload of opticians has been reduced. Only the responsible manager of the relevant optical store, who may practice the profession of optician, is registered in the Medula-Optical Provision System. The username and password of the responsible manager of that optical store, as well as the fixed IP of the modem registered to SGK, can be accessed to establish a connection to the system [21–25]. There is also a product tracking system (ÜTS, Ürün Takip Sistemi, in Turkish) for sight-aid medical supplies. The ÜTS Project is used to track all medical devices and cosmetic products manufactured or imported in Türkiye, from the production line to the place where they are sold and used, and to track them down to the end user. It is also possible to detect counterfeit products with ÜTS. In the ÜTS registration process, the user logs into the system with the username of the business owner whose ÜTS institution number is provided. In the branched optical stores, ÜTS user is one person that is natural person with a tax plate or private law legal entity for company. The product stock control for all branch offices of the optical stores affiliated with the company owner but having different ÜTS numbers is carried out and kept under control. It is possible to log into the system with the user registered in ÜTS through the e-government portal or using electronic signature (e-signature) or mobile signature. It is within reach to list, query, view dealership and companies of medical devices through the Information Bank of the ÜTS. Health Practice Notification (SUT, Sağlık Uygulama Tebliği, in

Turkish) transactions, product movements, production/import notification, stock notification, and export/receive notification can be made. ÜTS should record medical devices and cosmetic products, to create an infrastructure to monitor these products, to contribute to the protection of patient safety and public health, to ensure that the audits are carried out healthily and effectively, to take quick measures against product-related hazards, and to ensure that unsafe products are quickly removed from the market and from use to ensure its removal. In Figure 2, it is aimed to create a national and proprietary product tracking model, the infrastructure for the healthy and efficient monitoring of medical devices and cosmetics, inspection services, and clinical scientific processes in cooperation with Türkiye Medicines and Medical Devices Agency. [26, 27].

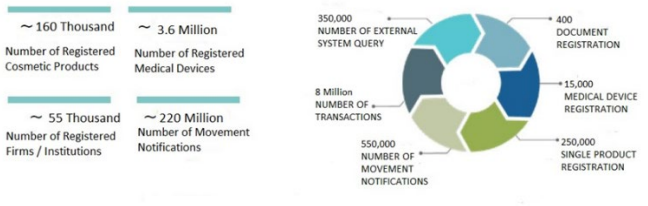

Figure 2. Inspection of medical devices and cosmetics in cooperation with the Türkiye Medicines and Medical Devices Agency

There are also specialized package programs 100% integrated with Medula and ÜTS, reducing the workload of the optical store, saving time, and tracking customers. Optical package programs are software used by opticians and scientific opticians and designed for the needs of optic stores. Access is possible from anywhere. These programs can be used from any device connected to the Internet, and accounts can be accessed. It provides easy use. The unlimited device feature is among the program features. You can connect to the system with as many devices as you want, either in-house or remotely. Opticians can perform many operations using these auxiliary optical package programs. These digital programs help opticians related to their businesses to manage sales, inventory, invoices, reports, customer records, and other transactions. They have modules such as product stock management, current accounts, sales order management, connecting to official institution Medula, cash register tracking, and customer relations management. They help you with stock statistics (the stock distribution of brands according to branches, wholesalers, and merchandise based on number, cost, and sales value), sales statistics, special reports, income reports, lists, current account reports, stock reports, sales reports, products, and consumables. These digital optical package programs increase the efficiency of businesses, reduces the workload, and increases customer satisfaction. They also help businesses become more successful financially. In Figure 3, as an example of the operations carried out with optical package programs, the distribution of stock according to the products is shown in the Siber Optik (Cyber Optic) Turkish Package Program Stock Statistics Module. Siber Optik is one of the popular optical package programs used in Türkiye. In Figure 4, Siber Optik Turkish Package Program-Stock Statistics Module, stock distribution by branches is shown [28–29].

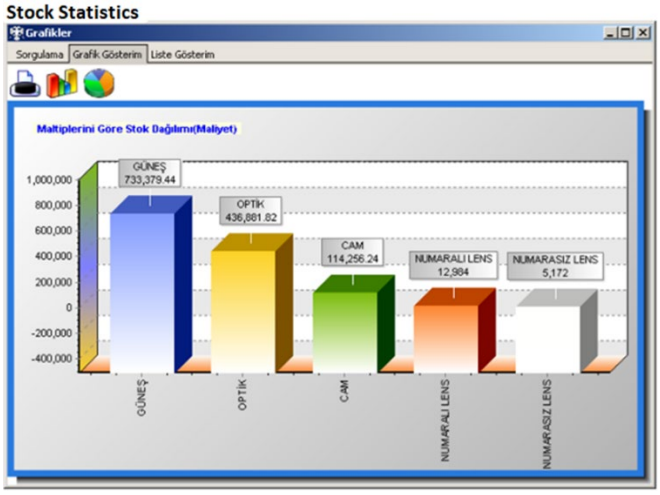

Figure 3. Siber Optik Turkish Package Program-Inventory Statistics Module, stock distribution by product type

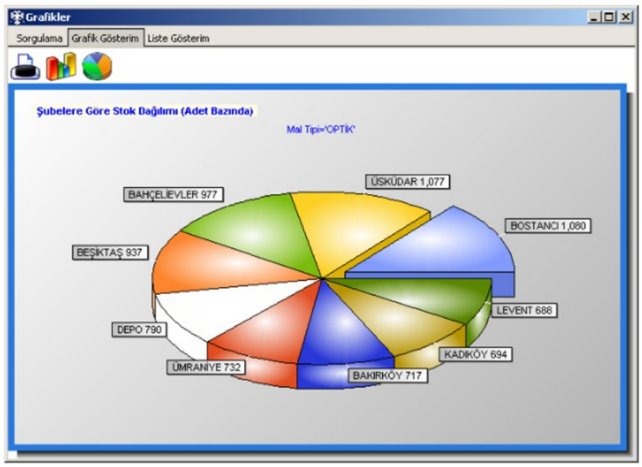

Figure 4. Siber Optik Turkish Package Program - Stock Statistics Module, Stock Distribution by Branches

Optical package programs allow a variety of operations to be performed. These operations may include:

3.1. Keeping Customer Records and Keeping Eye Examination Records

Optical package programs allow the recording of customer information and products purchased. It facilitates the keeping and updating of customer records. The optical

package program allows to save customer information such as customers' name, address, phone number, e-mail address, and other important information. This can help you keep important information about your customers and communicate with them more easily. In this way, customers' health data, eye prescriptions, and other important information are recorded and stored more systematically. Customer relationship management becomes easier. As in Figure 5, a record list is created with the customer tracking form. There is no objection in calling consumers customers in the sale of cosmetic contact lenses or non-diopter (unnumbered, non-dioptric power) sunglasses. However, it is more appropriate to use the terms “vision equipment consumer”, “eyeglass user”, “eyewear user” or “patient” instead of “customer”, since eye health services are in optical stores which serve as semi-healthcare institutions. Records of patients are kept in this digital program [28–29].

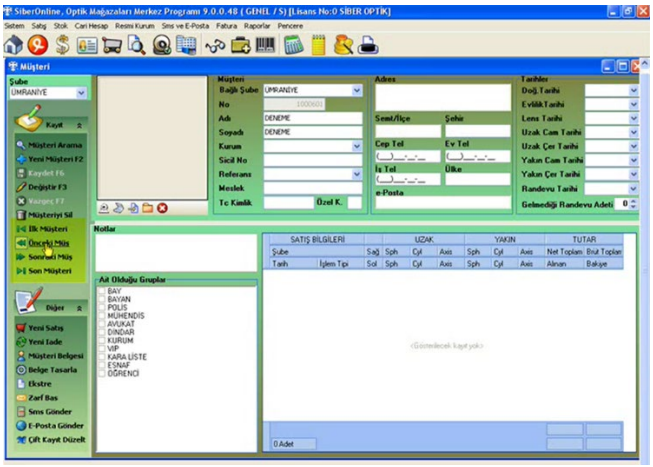

Figure 5. Siber Optik customer tracking form in Turkish

Optical package programs allow opticians to save eye examination records (sph, cyl, and ax) belonging to consumers of vision equipment. Opticians can record data obtained because of eye exams. In this way, opticians can have better information about the health status of patients. Patients' eye health data becomes more easily accessible at each visit. Optical package programs can save patients' eye prescriptions, making them easily accessible when needed. In this way, opticians can review patients' past prescriptions and inform them more accurately [28–29].

3.2. Optical Lens and Contact Lens Tracking

Opticians can record sales of eyeglasses (eyeglass frames and ophthalmic lenses; ophthalmic lenses is also known as lenses or corrective lenses) and contact lenses with optical package programs. They can enter lens color, lens type, lens product name, and eyeglass frame type information. This allows them to follow eyeglasses (eyeglasss lens and eyeglass frame) and contact lenses. In this way, opticians can be better informed about when their clients or patients should replace their lenses or contact lenses [28–29].

3.3. Stock Management

Stock management is important for optical stores. Optical package programs facilitate the tracking and renewal of products in stock. This is important for keeping track of the stock of products in your store and placing orders. It also provides a significant ease of operation for branched optical stores. When the sales process is complete, the stock count is automatically updated, and the number of items remaining in stock is automatically reduced [28–29].

3.4. Sales and Payment Transactions

Optical package programs facilitate the management of orders and sales by vision equipment consumers or customers. This way, sales transactions can be carried out more quickly and efficiently. It helps you manage the sales processes for the products in your store. This allows you to check the prices and availability of products in your store and sell products to customers. After receiving payment from the customer, the optical package program calculates the payment amount and creates the payment record. Optical package programs provide management and tracking of customer payments. In this way, financial transactions can be carried out in a more secure and organized manner. It allows you to accept payments from your customers, track payment records, and issue payment receipts to customers. Payment can be made by different methods, such as cash, credit card, or bank transfer. The salesperson enters the payment method chosen by the customer into the system, and the payment process is completed. The Optical Package Program allows you to generate invoices for sales transactions made to customers. The invoice creation process includes information such as prices, quantities, and total amounts of products. This helps you keep financial records for your store [28–29].

3.5. Reporting

Optical package programs offer reporting features for analyzing sales, stock, customer, and various other data. This comprehensive data analysis empowers opticians to gain profound insights, thereby allowing them to make informed decisions and strategic adjustments. In this way, it helps opticians better understand the performance of their businesses by allowing them to measure the performance of their businesses. Opticians can better understand the strengths and weaknesses of their business, and changes can be made when necessary. It enables us to have feedback on

progress. The valuable feedback derived from these reports serves as a roadmap for implementing necessary changes and optimizing overall efficiency. This dynamic feedback loop contributes to a continuous cycle of progress and refinement in the realm of opticianry business management [28–29].

3.6. Return Procedures

The Optical Package Program assists in managing returns when consumers or customers return products. This allows you to accept return requests from your customers, receive returned products, and complete the return transactions. In addition to streamlining the return process, the Opticianry package programs also offer insights into sales trends and enable you to evaluate your business's performance through its comprehensive reporting features [28–29]. These programs allow you to seamlessly manage return requests from your customers, enabling you to accept return requests, log returned products, and ultimately complete the return transactions [30]. While the program simplifies these processes, it also speeds up operations and minimizes errors through its automated workflows [31]. This program is not limited to return management; it also allows you to analyze sales trends and evaluate business performance through its comprehensive reporting features [32]. This helps enhance overall business efficiency and aids in strategic decision-making [33]. AI systems process large amounts of personal and medical data, making data security and privacy of critical importance [34]. In this context, it is essential to explain how AI-based systems will provide security against data breaches and how these processes will comply with legal regulations (e.g., KVKK in Türkiye, GDPR in Europe) [35]. Compliance with such regulations is vital to gaining the trust of both users and patients [36]. Additionally, the accuracy and reliability of AI algorithms depend on the diversity and quality of the training data [37]. If the data is biased or incomplete, AI systems may produce incorrect or unfair outcomes [38]. Therefore, it is imperative to identify, assess, and implement strategies to mitigate potential bias risks in these systems [39]. It is essential to ensure transparency in AI decision-making processes, particularly in specialized fields such as opticianry [40]. The accuracy and reliability of these decisions must be demonstrated transparently, allowing users and healthcare professionals to confidently evaluate AI-generated solutions [41]. Financial benefits provided by AI should also be considered. For instance, the financial impacts, such as initial investment costs and long-term savings, should be detailed, enabling stakeholders to make informed decisions about the integration of AI into business processes and its long-term advantages [42]. Compliance with legal regulations in this process increases user trust and ensures the sustainable application of AI. In sectors like the optical industry, where both technology and human interaction play a significant role, the reliability of AI-based systems enhances the user experience while boosting business competitiveness [43]. Furthermore, the integration of AI into such systems not only streamlines operational processes but also significantly contributes to the advancement of professional expertise in fields like opticianry. By aligning regulatory compliance with technological advancements, AI fosters both innovation and efficiency across various industries. In brief, thanks to Medula and optical package programs, it becomes easy to track optical products through ÜTS, including payment details, purchase history, and other pertinent information (such as eyewear equipment orders recorded in the package program) related to consumer or customer relationship management. When these programs have artificial intelligence properties, like OpenAI [44], it is possible to access and gain academic knowledge through them. AI-powered software can make accurate academic information easily accessible with enhancing the quality of opticianry services and increasing the number of qualified opticians.

4. Conclusion

There is great interest in developing optical solutions using deep learning architectures. The rapid growth of deep learning technology to solve various problems in optics has led to a paradigm shift from physics and data-driven modeling to data-driven learning. Deep learning is often useful in many complex applications and in optical metrology with complex physical models. According to strong empirical and experimental data, using problem-specific deep learning models outperforms traditional knowledge or physical model-based techniques. Despite the encouraging and even impressive results documented in the literature, potential problems and challenges remain. Large amounts of labeled experimental data must train models, but even when they are available, obtaining them is time-consuming and requires expertise. We seek theoretical foundations that clearly explain the mechanisms and approaches for choosing the best network structure and training algorithm for a task or have a deep understanding of why a particular network structure or algorithm is effective for each task. Deep learning methods are sometimes called "black boxes," and their optical responsibility is critical and can have serious consequences. A combination of data-driven models that learn adjustments based on experimental data and physics-based models that represent prior imaging knowledge can integrate our domain knowledge with deep learning and provide physically more realistic responses to specific optical challenges. Using these cutting-edge technologies to apply deep learning techniques in optical imaging can stimulate and accelerate the adoption of deep learning in other application areas. Artificial intelligence will help reduce the cost of eye care through the automation of certain processes and a reduction in human error and waste. It will improve the training and education of opticians. AI will help opticians update their knowledge and acquire new skills by providing personalized and interactive learning resources and feedback. AI will also facilitate the assessment and certification of these professionals, using unbiased and

standardized techniques to analyze opticians' abilities and performance. Opticians and scientific opticians can find academic help with artificial intelligence-based software for all their questions about their profession. With the programs to have artificial intelligence software, opticians and scientific opticians can access accurate academic information, and access to information will be facilitated. Detailed information about everything related to eye, especially the refractive errors of the eye, and the products supplied will always be accessible supported by artificial intelligence in optical package applications. AI can transform opticianry education programs and improve outcomes for opticianry professionals. However, the ethical, legal, and societal implications of AI, such as maintaining the human touch and trust in eye care and addressing issues and limitations regarding the quality and security of AI systems and data, need to be considered. Therefore, opticianry programs should adopt a cautious and balanced approach when incorporating AI into their curriculum and practices. These are some of the most important topics that will keep the optical community interested in deep learning research for years to come. When all kinds of official or private optical programs are supported by AI, it is possible to gain academic knowledge through these programs. While integrating AI into opticianry education and practices has the potential to elevate service quality, the augmentation in the number of qualified opticians remains contingent upon a variety of factors.

Ethics in Publishing

There are no ethical issues regarding the publication of this study.

References

[1] Gao, P. et al., (2012) Autofocusing of digital holographic microscopy based on offaxis illuminations, Opt. Lett. 37, 3630–3632.

[2] Dubois, F. et al., (2006) Focus plane detection criteria in digital holography microscopy by amplitude analysis, Opt. Express 14, 5895–5908.

[3] Pan, B. et al., (2009) Phase error analysis and compensation for nonsinusoidal waveforms in phase-shifting digital fringe projection profilometry, Opt. Lett. 34, 416–418.

[4] Feng, S. J. et al., (2018) Robust dynamic 3-D measurements with motioncompensated phase-shifting profilometry, Opt. Lasers Eng. 103, 127–138.

[5] Ferraro, P. et al., (2003) Compensation of the inherent wave front curvature in digital holographic coherent microscopy for quantitative phase-contrast imaging, Appl. Opt. 42, 1938–1946.

[6] Di, J. L. et al., (2009) Phase aberration compensation of digital holographic microscopy based on least squares surface fitting. Opt. Commun. 282, 3873–3877.

[7] Miccio, L. et al., (2007) Direct full compensation of the aberrations in quantitative phase microscopy of thin objects by a single digital hologram. Appl. Phys. Lett. 90, 041104.

[8] Colomb, T. et al., (2006) Total aberrations compensation in digital holographic microscopy with a reference conjugated hologram. Opt. Express 14, 4300–4306.

[9] Zuo, C. et al., (2013) Phase aberration compensation in digital holographic microscopy based on principal component analysis, Opt. Lett. 38, 1724–1726.

[10] Martínez, A. et al., (2008) Analysis of optical configurations for ESPI, Opt. Lasers Eng. 46, 48–54.

[11] Wang, Y. J. & Zhang, S., (2013) Optimal fringe angle selection for digital fringe projection technique, Appl. Opt. 52, 7094–7098.

[12] Michie, D., Spiegelhalter, D. J. & Taylor, (1994) C. C. Machine learning. Neural Stat, Classification. Neural Stat. Classif. 13, 1–298.

[13] Qingtian Zhang, Weitao Song, Yue Liu, Yongtian Wang, Design and implementation of an optical see-through near-eye display combining Maxwellian-view and light-field methods, Optics Communications, Volume 510, 2022, 127833.

[14] Giannakos, Michail & Voulgari, Iro & Papavlasopoulou, Sofia & Papamitsiou, Zacharoula & Yannakakis, Georgios. (2020). Games for Artificial Intelligence and Machine Learning Education: Review and Perspectives.

[15] Michie, D., Spiegelhalter, D. J. & Taylor, (1994) C. C. Machine learning. Neural Stat. Classification, Neural Stat. Classif. 13, 1–298.

[16] Zhang, X. D., Machine learning. in A Matrix Algebra Approach to Artificial Intelligence (ed. Zhang, X. D.) 223–440 (Springer, 2020).

[17] McCulloch, W. S. & Pitts, W., (1943) A logical calculus of the ideas immanent in nervous activity, Bull. Math. Biophysics 5, 115–133.

[18] Long, J., Shelhamer, E. & Darrell, T. Fully convolutional networks for semantic segmentation. In Proceedings of 2005 IEEE Conference on Computer Vision and Pattern Recognition. 3431–3440 (IEEE, Boston, MA, 2015).

[19] Sheng-Yao Huang, Wen-Lin Hsu, Ren-Jun Hsu and Dai-Wei Liu, Fully Convolutional Network for the Semantic Segmentation of Medical Images: A Survey, Diagnostics 2022, 12, 2765.

[20] Chen, Q. F., Xu, J. & Koltun, V. Fast image processing with fully-convolutional networks. In Proceedings of 2017

IEEE International Conference on Computer Vision. 2516–2525 (IEEE, Venice, 2017).

[21]https://www.mevzuat.gov.tr/File/GeneratePdf?mevzuatNo=19311&mevzuatTur=KurumVeKurulusYonetmeligi&mevzuatTertip=5, Access Date: 25.03.2023

[22] https://optik.sgk.gov.tr/Optik_Firma_Web/login.jsp, Access Date: 25.03.2023

[23]https://www.sgk.gov.tr/Duyuru/Detay/Sosyal-Guvenlik-Kurumu-Gormeye-Yardimci-Tibbi-Malzemelerin-Teminine-Iliskin-Sozlesme-2022-11-23-02-10-42, Access Date: 31.03.2023

[24] https://www.mevzuat.gov.tr/MevzuatMetin/1.5.5193.pdf, Access Date: 31.03.2023

[25] Kara,İ., (2020) Türkiyede Optik Sektörü ve Optisyenlik Mesleğinin Değerlendirilmesi, Selçuk Sağlık Dergisi, Sayı:1.

[26] https://bilgem.tubitak.gov.tr/tr/urunler/urun-takip-sistemi, Access Date: 25.03.2023

[27] https://utsuygulama.saglik.gov.tr/UTS/, Access Date: 30.03.2023

[28] https://temaoptik.com/, Access Date: 25.03.2023

[29] https://www.siberoptik.com.tr/, Access Date: 25.03.2023

[30] Röllecke, F. J. et al., (2018) Returning customers: The hidden strategic opportunity of returns management, Calif. Manag. Rev. 60(2), 176-203.

[31] Georgakopoulos, D. et al., (1995) An overview of workflow management: From process modeling to workflow automation infrastructure, Distrib. Parallel Databases 3, 119-153.

[32] Montabon, F. et al., (2007) An examination of corporate reporting, environmental management practices and firm performance, J. Oper. Manag. 25(5), 998-1014.

[33] Jansen, R. J. et al., (2013) Information processing and strategic decision-making in small and medium-sized enterprises: The role of human and social capital in attaining decision effectiveness, Int. Small Bus. J. 31(2), 192-216.

[34] Chen, Y., & Esmaeilzadeh, P., (2024) Generative AI in medical practice: in-depth exploration of privacy and security challenges, J. Med. Internet Res. 26, e53008.

[35] Uysal, I. (2023) Empowering Privacy in the Digital Age: AI Innovations in Healthcare, IJICTDC, 8(1), 49-60.

[36] Steinberg, E. et al., (2011) Clinical practice guidelines we can trust. national academies press.

[37] Liang, W. et al., (2022) Advances, challenges and opportunities in creating data for trustworthy AI, Nat. Mach. Intell. 4(8), 669-677.

[38] Ferrara, E. (2023) Fairness and bias in artificial intelligence: A brief survey of sources, impacts, and mitigation strategies, Sci 6(1), 3.

[39] Mensah, G. B. (2023) Artificial intelligence and ethics: a comprehensive review of bias mitigation, transparency, and accountability in AI Systems. Preprint, November, 10.

[40] Li, J. P. O. et al., (2021) Digital technology, tele-medicine and artificial intelligence in ophthalmology: A global perspective, Prog. Retin. Eye Res. 82, 100900.

[41] Magrabi, F. et al., (2019) Artificial intelligence in clinical decision support: challenges for evaluating AI and practical implications, Yearb. Med. Inform. 28(01), 128-134.

[42] Bredt, S. (2019) Artificial Intelligence (AI) in the financial sector—Potential and public strategies, Front. Artif. Intell. 2, 16.

[43] Truby, J. (2020) Governing artificial intelligence to benefit the UN sustainable development goals, Sustain. Dev. 28(4), 946-959.

[44] https://openai.com/, Access Date: 30.03.2023