



Next-Generation Diagnostics: AI And Optical Biosensors In Cancer And Retinal Health – A Review

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Abstract: The integration of artificial intelligence (AI) with optical biosensors has been an introduction to a new era in biomedical diagnostics, offering potential capabilities for the early detection of cancer, and precision and accurate retinal imaging. This review critically examines the transformative blend between AI algorithms and optical biosensing technologies, including surface plasmon resonance (SPR), fluorescence spectroscopy, and optical coherence tomography (OCT). These systems provide non-invasive, high-sensitivity diagnostic platforms capable of detecting subtle biomolecular interactions and imaging minute cellular structures, crucial for addressing the global burden of cancer and vision-related diseases.

AI-powered optical biosensors enhance advanced computational techniques such as deep learning, convolutional neural networks (CNNs), and generative adversarial networks (GANs) to process complex datasets, optimize signal interpretation, and enhance diagnostic accuracy. SPR, known for its precision in detecting biomarker interactions, faces challenges like noise interference and high operational costs, which AI addresses by improving signal-to-noise ratios and automating data analysis. Similarly, fluorescence-based biosensors benefit from AI-driven algorithms to counteract limitations such as photobleaching, spectral overlap, and false positives. In retinal imaging, OCT achieves remarkable resolution, yet struggles with artifacts and restricted visualization scopes, which AI alleviates through real-time motion correction, enhanced depth resolution, and predictive imaging techniques.

This review also compares the relative strengths and limitations of various AI-augmented optical biosensors, emphasizing their practical applications in clinical and research settings. Key challenges include the need for standardized datasets, the ethical implications of AI deployment, and barriers to widespread adoption due to cost and infrastructure requirements. Future innovations are anticipated to include hybrid biosensor platforms that integrate multiplexed detection capabilities, AI-enhanced multimodal imaging, and adaptive learning models capable of personalizing diagnostic outputs to individual patient profiles.

In conclusion, AI-empowered optical biosensors represent a paradigm shift in diagnostic science, combining the precision of optics with the predictive power of AI to redefine early disease detection and management. Addressing current limitations through interdisciplinary collaboration and technological advancement will be pivotal in achieving scalable, cost-effective, and universally accessible solutions, thereby transforming healthcare delivery on a global scale.

Index Terms - Artificial Intelligence, OCT, Biosensors, CNN's and GAN's, SPR, Fluorescence spectroscopy, optical interferometry

I. INTRODUCTION

The optical interferometry has seen a rapid growth in the development and scientific progress over the past few years. Interferometry is based on the principle of interference between two waves and its superposition. It uses the interference of electromagnetic waves with wavelengths (λ Symbol) in the range of visible light or nearby the wavelength is approximately between 10^{-7} and 10^{-6} m¹. The basic form for this method of sensing relies on splitting coherent light into two beams, arranging the beam paths such that one path length is dependent on the displacement of interest, and then recombining the beams to generate an interference pattern². The fundamental principle behind OI is constructive and destructive interference. When two coherent light waves overlap, their amplitudes combine, creating either reinforcement (constructive) or the annihilation or the cancellation (destructive) depending on their relative phases. The resulting interference fringes are recorded and analysed to extract precise measurements³. OI has revolutionized precision measurements in science and engineering. Some of its key applications include:

1. **Astronomy:** Optical interferometry enables astronomers to resolve fine details of celestial objects, such as measuring the diameters of stars, observing exoplanets, and imaging distant galaxies. Instruments like the Very Large Telescope Interferometer (VLTI) have significantly advanced this field⁴.
2. **Metrology:** OI is widely used in industrial and scientific metrology for measuring distances, surface profiles, and refractive indices with nanometer-scale precision⁵.
3. **Medical Imaging:** Optical coherence tomography (OCT), an interferometric technique, is a non-invasive imaging modality for visualizing biological tissues, particularly in ophthalmology⁶.
4. **Spectroscopy:** Interferometers like the Michelson and Fabry-Pérot are integral to spectroscopic analysis, enabling high-resolution measurements of spectral lines⁷.
5. **Gravitational Wave Detection:** Instruments such as LIGO utilize laser interferometry to detect minute spacetime distortions caused by gravitational waves⁹.

OI's versatility extends to applications like **fiber optic communication, holography**, and even in **quantum computing**, where it facilitates the manipulation of quantum states¹⁰. This review article encapsulates the application of AI based OI and its future prospects.

Medical imaging is one of the most impactful applications of **optical interferometry (OI)**, particularly through techniques such as **Optical Coherence Tomography (OCT)**. OCT is a non-invasive imaging modality that employs low-coherence interferometry to capture cross-sectional images of biological tissues with micrometer-level resolution. It has revolutionized cancer detection and retinal imaging by enabling early diagnosis and detailed visualization of pathological changes.

Cancer Detection with Optical Interferometry

OI is highly effective in detecting early-stage cancer due to its ability to analyze the microstructural properties of tissues. OCT can differentiate between normal and cancerous tissues by measuring light scattering and absorption properties, which vary between healthy and diseased cells.

1. **Tissue Differentiation:** Cancerous tissues often show increased optical scattering due to cellular abnormalities such as increased nuclear size, irregular cell boundaries, and altered collagen structures. OCT provides high-resolution images that allow for precise identification of such changes¹¹.
2. **Skin Cancer Detection:** OCT is widely used for diagnosing non-melanoma skin cancers, such as basal cell carcinoma and squamous cell carcinoma. It enables non-invasive imaging of the epidermis and dermis, identifying tumor margins without the need for biopsies¹².
3. **Breast and Cervical Cancer:** OCT can also be applied in detecting cancers in epithelial tissues, including breast and cervical regions, where it provides real-time imaging during surgical procedures or biopsies, improving the accuracy of interventions¹³.
4. **Functional Imaging:** Advanced forms of OCT, such as angiographic OCT, enable visualization of blood flow within tumors, assisting in the study of tumor vascularization, which is a key factor in cancer progression.

Retinal Imaging with Optical Interferometry

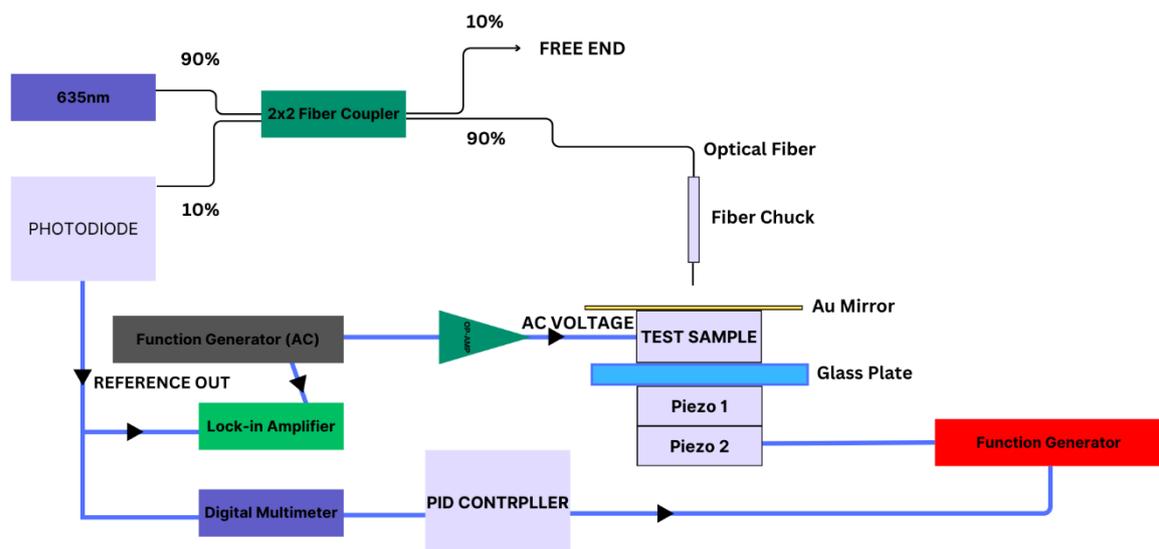
OI has had a profound impact on **ophthalmology**, especially in the early detection and management of retinal diseases. OCT has become a gold standard for non-invasive imaging of the retina due to its ability to visualize the retinal layers in unprecedented detail.

1. **Diagnosis of Retinal Diseases:** OCT is extensively used in detecting diseases such as macular degeneration, diabetic retinopathy, and retinal detachment. It provides high-resolution cross-sectional images of the retina, enabling clinicians to monitor disease progression and evaluate treatment efficacy¹⁴.
2. **Diabetic Retinopathy:** Diabetic retinopathy leads to changes in retinal microvasculature, causing fluid buildup, macular edema, and retinal ischemia. OCT helps quantify retinal thickness and detect fluid accumulation, providing critical insights for early diagnosis¹⁵.
3. **Glaucoma:** OI enables early detection of glaucoma by measuring the thickness of the retinal nerve fiber layer (RNFL) and optic disc parameters, which are essential for assessing glaucomatous damage.
4. **Retinal Angiography:** Optical coherence tomography angiography (OCTA) extends the capabilities of OCT by visualizing blood flow within the retinal and choroidal vessels. OCTA is particularly useful in diagnosing and monitoring conditions like macular ischemia and choroidal neovascularization, which are often associated with age-related macular degeneration (AMD)¹⁶.
5. **Pediatric Applications:** OCT is also employed in detecting congenital retinal disorders, such as retinopathy of prematurity (ROP), facilitating timely interventions.

Advances in Optical Interferometry for Medical Imaging

In recent years, innovations in OI technology have further enhanced its capabilities:

- **Swept-Source OCT:** Provides faster imaging speeds and deeper tissue penetration, enabling visualization of choroidal structures beneath the retina.
- **Polarization-Sensitive OCT (PS-OCT):** Enables imaging of birefringent tissues, such as collagen and retinal layers, offering additional contrast for better diagnostic accuracy.
- **Functional OCT:** Combines structural imaging with physiological measurements, such as oxygen saturation levels and blood flow dynamics.



Block Diagram of a developed Optical Interferometer

Fig.1: Illustration of an Optical Interferometer

Clinical Impact

The ability of OI-based imaging to detect microstructural and functional changes in tissues has made it indispensable in both cancer detection and retinal imaging. Its non-invasive nature ensures patient comfort, while its high resolution aids in early diagnosis, improving treatment outcomes significantly. The analysis of extensive datasets, identification of specific patterns, and the calling of anomalies missed by clinicians is where the AI technology shines most. In medicine, Artificial Intelligence can enable the advancement of imaging techniques such as X-ray and CT scans which allows doctor to identify diseases with more precision using AI powered abnormality detection. AI ensures maximum reduction of human error during diagnosis which allows medical professionals to swiftly attend to the patient's needs. As a result, patient outcomes improve and the processes in the medical clinic become more efficient.

Additionally, the use of Optical Imaging (OI) together with AI systems has tremendously altered the approach to detecting diseases like cancer as well as retinal disorders. Furthermore, algorithms that utilize AI have proven to be very useful when processing high optical image resolutions. These types of images will usually contain indicators of early stage diseases such as microaneurysms or tumor margins found in retinal scans. That said, this technique enables superior diagnostics since it's non-invasive and inexpensive, as well as makes the effort put into image analysis minimal. With the progress of AI, the capabilities of the technology to tailor treatments specialized for specific patients continues to develop. This trend is made possible by the vast improvement of the personal approach to medicine. As a result, managing complex diseases becomes much easier.

Even more profoundly, the mixture of AI with OI has proven to be advantageous in actual application settings. The combination enhances the efficiency of cancer diagnostics whereby, the effectiveness of tumor histopathological declassification is improved and the subsequent predictions made on patient's status accurate. This new endeavour will lead to new findings, new explorations and new ways in the field of medicine and change the way things used to be.

II. METHODOLOGY

The literature survey was conducted using resources such as Google Scholar, PubMed, Wiley and Elsevier and reputed journal sites to gather a wide range of relevant studies. Additionally, a comparative analysis was performed to evaluate optical interferometry alongside other techniques, including Surface Plasmon Resonance (SPR), Localized Surface Plasmon Resonance (LSPR) and Fluorescence resonance energy transfer (FRET). These investigations provided critical insights into the strengths, limitations, and applicability of these methods, particularly in specialized fields such as cancer diagnosis and retinal imaging. This systematic review enabled the identification of significant advancements in optical sensing technologies, highlighting their evolving role in non-invasive medical diagnostics. In summary, the literature review and comparative studies served as a robust foundation for building this review article.

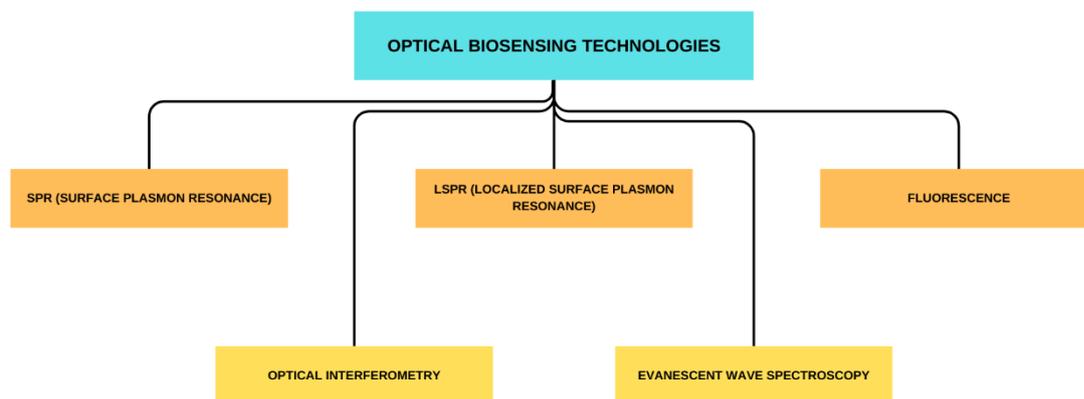


Fig.2: Optical Biosensing Technologies

III. TECHNOLOGICAL OVERVIEW

The integration of Artificial Intelligence (AI) in Optical Interferometry (OI) has emerged as a transformative milestone in healthcare, particularly in cancer diagnosis and retinal. Machine learning (ML) is assisting in transforming the healthcare industry for the better with its cutting-edge applications¹⁷. This serves as one major step forward in AI-enabled OI as it creates more precise algorithms and automates the image processing steps of different medical imaging modalities such as Optical Coherence Tomography (OCT). These are non-surgical methods that visualize the internal structure of biological tissues in cross-sections at the micron scale. This type of imaging is great in the field of medicine. AI allows for faster and better patient specific treatments and monitoring of the changes in the patient's condition.

Optical coherence tomography (OCT) is a technique based on interferometry, a resolution cross sectional images of biological system in materials based on the partial interference of light that bounces of the sample in references to the normal light beam. The resolution of OCT is much higher than that of other medical imaging methods like ultrasound or magnetic resonance imaging (MRI)¹⁸. This technique plays a crucial role in mapping of various biological systems with much accuracy in microscale level. OCT, this method is employed in the detection malignant cancer and retinal disorders. AI/ML can lead to methods for integrating, analyzing and understanding multiple sources of data, in order to enhance and personalize medical practice¹⁹. Nonetheless, this technique has its drawbacks: the instrumental deflection noise and background interference severely hinders data interpretation, as does the difficulty in interpretation of intricate biological models and the errors present in training sets. Medical technology has the potential to be enhanced to a greater extent if the machine-learning-based systems are integrated into the later stages of data collecting, noise suppression, and analysis. With this in mind, earlier stages of tumors and retinal diseases could also be diagnosed and treated.

3.1 Artificial Intelligence (AI) in Cancer Diagnosis:

Cancer is a multi-step process involving genetic and epigenetic modifications that disrupt the cellular homeostasis between cellular growth and death. Cancer is a major illness that kills millions of individuals annually throughout the globe²⁰. AI plays a crucial role in cancer diagnosis, enabling early intervention and significantly improving patient outcomes. By analyzing complex datasets and identifying subtle patterns in imaging and biomarkers, AI enhances the precision of early cancer diagnosis. Optical biosensors offer a non-invasive approach to detecting cancer biomarkers. Most cancer-derived substances, such as miRNA, CTCs, proteins, exosomes, and DNA, are employed in optical biosensors²¹. With the help of AI integrated Optical Interferometry (OI), tumor cells can be located and classified for personalized treatment plans at an

unparalleled speed. Non-invasive imaging allows for the detection of cancerous changes in tissues without needing to do a biopsy which in turn reduces the risk and discomfort faced by the patient. This technology also enables physicians to track real-time changes in the tissues during the treatment so that appropriate measures can be taken if the therapy does not seem effective. In some retrospective studies, the analysis has shown that deep learning of digitized pathology slides has the capability of improving the accuracy and speed of the diagnosis. Apart from classifying tumors more accurately by data processing, the use of a deep-learning algorithm to sharpen out-of-focus images may also prove useful²². However, limitations such as ethical concerns, sensitivity to temperature fluctuations currently pose challenges to the widespread adoption of these technologies. Nevertheless, as AI in healthcare continues to evolve and diversify, these barriers are expected to be mitigated through advancements in robust algorithms and the implementation of firm ethical standards, paving the way for more reliable and efficient applications in the future.

Thus, AI technology can be used to support the overall reporting system, speed up reporting time and measure morpho-biological features more objectively. AI aided reporting of certain features or lesions will also enable pathologists to focus on challenging cases and meet the increasing workload demands. Implementation of such technology in the workflow of pathology service is not to replace the human resources including pathologists, and laboratory technicians, but to provide support for them, assist them and augment diagnostic and performance efficiency with better allocation of resources, increased cost-effectiveness of the service and more consistent pathology reviews²³.

3.2 Artificial Intelligence (AI) in Retinal Imaging:

The human eye is an important organ for the perception, transformation, transmission, and assimilation for visual information. Amongst the various complex tissues of the human eye, the retina is a vital component enabling detection of a single photon. However, ocular defects are highly prevalent in the modern world. The most common causes of visual impairment are refractive errors, cataracts, glaucoma, age-related macular degeneration, corneal opacification, diabetic retinopathy, childhood blindness and trachoma²⁴. Millions of people worldwide live with retinal disease and the accompanying threat of severe vision loss or blindness²⁵. AI has revolutionized retinal imaging in retinopathy by providing highly accurate and precise imaging, significantly improving diagnosis and enabling personalized treatment plans for patients. Machine Learning algorithms can automatically detect subtle retinal abnormalities and management of conditions like diabetic retinopathy. This technology facilitates real-time monitoring of disease progression and predictive analysis, allowing clinicians to implement proactive treatment strategies and achieve better long-term outcomes for patients. OCT is one of the most widely-used non-invasive and noncontact imaging technologies in both clinical and academic researches, mainly for biomedical imaging and diagnosis. OCT has been acknowledged as a basic clinical tool for diagnosis and treatment monitoring in a large number of retinal diseases.

Additionally, OCT is increasingly used in the diagnosis and monitoring of age-related macular degeneration (AMD) particularly in the assessment of neovascular or wet AMD²⁶. This scan is necessary to determine glaucoma diagnosis. It is utilized to identify retinal nerve fibre layers around the optic nerve, a significant indicator of early glaucoma damage²⁷. Performance of a deep-learning algorithm for interpreting retinal optical coherence tomography (OCT) was compared with ophthalmologists for diagnosis of either of the two most common causes of vision loss: diabetic retinopathy or Age-related macular degeneration (AMD). One unique aspect of this study was the transparency of the two neural networks used, one for mapping the eye OCT scans into a tissue schematic and the other for the classifier of eye disease²⁸. Deep Learning algorithms performed similar sensitivity and specificity (all AUCs>0.96) to ophthalmologist diagnosis, showing its potentiality for early diagnosis of keratitis²⁹. Noise reduction is one of the most significant parts in OCT image processing, which is beneficial to subsequent processing and analysis, such as segmentation of layers and classification of diseases³⁰. Moreover, the user (patient) can watch a video that shows what portions of his or her scan were used to reach the algorithm's conclusions along with the level of confidence it has for the diagnosis. This sets a new bar for future efforts to unravel the 'black box' of neural networks³¹.

IV. ADVANTAGES OF AI INTEGRATED SYSTEMS

Artificial intelligence (AI) technology has gradually permeated into the healthcare field over the past few years, with intelligent technology added to the common place clinical practice. Since these computational methods excel at processing complex, massive, and abstract data that would require human intelligence, AI-related techniques have been employed to develop various intelligent medical applications³². Deep learning of

digitized pathology slides offers the potential to improve accuracy and speed of interpretation, as assessed in a few retrospective studies³³. In addition to that, these integrated systems adapt to individual needs, providing tailored recommendations or treatments. AI equipped Chatbots in healthcare assist patients by providing instant responses to medical queries, scheduling appointments, and offering basic health advice. Besides they help healthcare providers save time and focus on critical tasks. AI works on exploring the available data, towards finding the digital anomalies, data sorting, noise reduction, integrating bio-digital markets, and drawing conclusions for clinically relevant interpretation. To achieve such accuracy, AI plays two vital roles. The first is to focus on reducing the unwanted information before data transmission, which simultaneously reduces the energy required for wireless transmission. The second is to emphasize on the data quality issues, such as accuracy, reproducibility and stability³⁴. It also enhances safety and reduces complications during the surgeries. Noise reduction is one of the most significant parts in OCT image processing, which is beneficial to subsequent processing and analysis, such as segmentation of layers and classification of diseases³⁵. AI technology can be used to support the overall reporting system, speed up reporting time and measure morpho-biological features more objectively³⁶.

Furthermore, AI integrated systems enhance decision-making accuracy, boosting confidence in critical areas such as diagnostic treatments. Machine learning efficiently analyses vast amounts of diagnostic and retinal imaging data in real-time, enabling earlier disease detection, accurate monitoring, and more precise treatment planning for improved patient outcomes. Henceforth, AI integrated systems, such as telemedicine tools and portable diagnostic devices, bring advanced healthcare and technology to under resourced and remote regions.

V. FUTURE DIRECTIONS

Despite obvious advantages of accuracy and efficiency, deep neural networks face sharp criticism due to lack of interpretability, which forms a huge roadblock in clinical adoption. By understanding the 'black box' functionality or algorithms of the system we may move towards white box approach for more ethical reasons so that people may trust the technological in healthcare system. This internal workings without knowledge of what's going on may test the credibility of the data acquire which can be stolen and privacy level maybe under scrutiny. This has to be taken into serious consideration for the future adaption for sustainable healthcare problem. AI powered systems can be energy intensive. The advances in energy efficient models and hardware will make them more sustainable.

Moreover, by integrating AI in Optical Interferometry, we can reduce sensitivity to vibrations, temperature fluctuations, and external noise, which can distort measurements in diagnosis. Although AI's reliance on high-quality datasets can be challenging, initiatives to develop standardized and diverse datasets will enhance innovation and reliability in AI integrated interferometry. Additionally, using AI in healthcare interferometry raises privacy concerns, but it also drives to stricter ethical guidelines and data encryption to ensure secure and ethical use of AI integrated systems. These technologies can be complex and expensive, limiting their accessibility.

However, the rapid evolution of AI and sensor technologies will likely reduce costs and simplify systems, making them more affordable and user-friendly over time. Besides that, Optical interferometry stands out compared to other methods such as Surface Plasmon Resonance (SPR), Localized Surface Plasmon Resonance (LSPR) and Fluorescence resonance energy transfer (FRET) as it has high quality of resolution, high sensitivity and specificity for structural imaging. Moreover, its non-invasive nature makes it an outstanding tool for precise diagnostics and effective treatment monitoring, especially in patient-centric healthcare applications. Henceforth, the future of AI in healthcare related portable devices holds immense potential. Portable diagnostic tools equipped by AI will enable real-time health monitoring, facilitating early detection of diseases like diabetes, cardiovascular conditions, and cancer. Wearable devices, integrated with advanced algorithms, will provide personalized health care, empowering users to track vital parameters and manage chronic conditions more effectively. Furthermore, advancements in AI will enhance device adaptability, allowing continuous learning from user data for improved accuracy and functionality. These innovations will not only make healthcare more accessible but also promote proactive health management and improved patient outcomes globally.

VI. CONCLUSIONS

AI integrated optical interferometry (OI) is revolutionizing cancer diagnosis and retinal imaging by merging the unparalleled precision of optical technologies with the intelligence and adaptability of AI. Compared to other methods like Surface Plasmon Resonance (SPR), Localized Surface Plasmon Resonance (LSPR), and fluorescence resonance energy transfer (FRET) based techniques, optical interferometry stands out due to its superior resolution, higher sensitivity, and exceptional specificity. These advantages make it a robust tool for structural imaging and biomolecular analysis, offering unmatched accuracy in both diagnostic and therapeutic applications.

In cancer diagnostics, it enhances detecting subtle molecular changes, classifying tissue abnormalities, and monitoring tumor progression with remarkable precision, enabling earlier interventions and more targeted therapies. Additionally, AI integrated OI reduces the noise which is beneficial to subsequent processing and analysis, such as segmentation of layers and classification of diseases. Similarly, in retinal imaging, its high-resolution capabilities allow for the early detection and monitoring of conditions like diabetic retinopathy, glaucoma, and macular degeneration, significantly reducing the risk of vision loss. Besides that, AI enhances image segmentation and pattern recognition, allowing for more precise diagnosis and treatment planning. Moreover, the integration of AI enables real time processing of OCT images, reducing the time required for diagnosis and facilitating immediate clinical decision making.

The non-invasive nature of this technology enhances patient comfort while enabling continuous monitoring and dynamic adjustments to treatment plans. Its ability to integrate multimodal data, such as imaging and molecular biomarkers, ensures holistic and personalized healthcare solutions. As AI continues to evolve, these systems will become more efficient, accessible, and scalable, making them indispensable in precision medicine. Ultimately, AI integrated Optical Interferometry (OI) holds the promise of transforming healthcare by enabling earlier detection, better disease management, and improved patient outcomes across the globe.

REFERENCES

- [1] Wiora, G., Weber, M., Chanbai, S. (2013). Optical Interferometry. In: Wang, Q.J., Chung, YW. (eds) Encyclopedia of Tribology. Springer, Boston, MA. https://doi.org/10.1007/978-0-387-92897-5_317
- [2] Michael A. Cullian., Robert M. Panas., et al., Scaling electromechanical sensors down to the nanoscale., Sensors and Actuators A: Physical., Volume 187, November 2012, Pages 162-173., <https://doi.org/10.1016/j.sna.2012.08.035>
- [3] [7] Born, M., & Wolf, E. (1999). *Principles of Optics: Electromagnetic Theory of Propagation, Interference, and Diffraction of Light*. Cambridge University Press.
- [4] Colavita, M. M., & Lawson, P. R. (2003). Long-baseline optical interferometry. Publications of the Astronomical Society of the Pacific, 115(804), 965–980.
- [5] [10] Goodman, J. W. (2015). Introduction to Fourier Optics. Roberts and Company Publishers.
- [6] [11] Drexler, W., & Fujimoto, J. G. (Eds.). (2008). Optical Coherence Tomography: Technology and Applications. Springer., 2008
- [8] [9] Abbott, B. P., et al. (2016). Observation of gravitational waves from a binary black hole merger. *Physical Review Letters*, 116(6), 061102.
- [12] Welzel, J. (2001). Optical coherence tomography in dermatology: A review. *Skin Research and Technology*, 7(1), 1–9. DOI:10.1034/j.1600-0846.2001.007001001.x
- [13] Vakoc, B. J., Lanning, R. M., Tyrrell, J. A., & Bouma, B. E. (2009). Cancer imaging by optical coherence tomography: Preclinical progress and clinical potential. *Nature Medicine*, 15(10), 1219–1223. DOI: 10.1038/nm.1998

- [14] Hee, M. R., Izatt, J. A., Swanson, E. A., & Fujimoto, J. G. (1995). Optical coherence tomography of the human retina. *Archives of Ophthalmology*, 113(3), 325–332. DOI: 10.1001/archophth.1995.01100030081025
- [15] Drexler, W., Morgner, U., Ghanta, R. K., & Schuman, J. S. (2001). Ultrahigh-resolution ophthalmic optical coherence tomography. *Nature Medicine*, 7(4), 502–507. DOI: 10.1038/87613
- [16] Spaide, R. F., Klancnik, J. M., & Cooney, M. J. (2015). Retinal vascular layers imaged by optical coherence tomography angiography. *JAMA Ophthalmology*, 133(1), 45–50. DOI: 10.1001/jamaophthalmol.2014.4700
- [17] Mohd Javaid, Abid Haleem: Significance of machine learning in healthcare: Features, pillars and applications. Volume 3, 2022. [https://doi.org/10.1016/j.ijin.\(journey\)](https://doi.org/10.1016/j.ijin.(journey))
- [18] Silke Aumann, Sabine Donner: Optical Coherence Tomography (OCT): 2019, 59 J. F. Bille (ed.), High Resolution Imaging in Microscopy and Ophthalmology, https://doi.org/10.1007/978-3-030-16638-0_3.
- [19] [29] [34] Sagar S. Arya, Sofia B. Dias: The convergence of traditional and digital biomarkers through AI-assisted biosensing: A new era in translational diagnostics? Published by Elsevier B.V, 2023. <https://doi.org/10.1016/j.bios.2023.115387>.
- [20] [21] Das, S.; Devireddy, R.; Gartia, M.R. Surface Plasmon Resonance (SPR) Sensor for Cancer Biomarker Detection. *Biosensors* 2023, 13, 396. <https://doi.org/10.3390/bios13030396>.
- [22] [28] [31] [33] Eric J. Topol: High-performance medicine: the convergence of human and artificial intelligence. Vol 25, January 2019. <https://doi.org/10.1038/s41591-018-0300-7>.
- [23] [36] Saba Shafi, Anil V. Parwani: Artificial intelligence in diagnostic pathology. 18:109, 2023. <https://doi.org/10.1186/s13000-023-01375-z>.
- [24] [26] Yuqi Shi, Nan Jiang: Ophthalmic sensing technologies for ocular disease diagnostics. *Analyst*, 146, 6416–6444, 2021.
- [25] Delia Cabrera DeBuc: A Review of Algorithms for Segmentation of Retinal Image Data Using Optical Coherence Tomography. *Image Segmentation* 1, 15-54, 2011.
- [27] Monojit Manna, Lina Mondal: Deep Learning-Based Glaucoma Detection & Interdisciplinary Retinal Image view point Analysis for Eye Disorders using Convolutional Neural Networks. Vol. 1, 2024.
- [30] [35] Bin Qiu, Shuang Zeng: Comparative study of deep neural networks with unsupervised Noise2Noise strategy for noise reduction of optical coherence tomography images. *J. Biophotonics*, e202100151, 2021. <https://doi.org/10.1002/jbio.202100151>
- [32] Han Cheng, Hongtao Xu: Illuminating the future of precision cancer surgery with fluorescence imaging and artificial intelligence convergence. 8:196, 2024. <https://doi.org/10.1038/s41698-024-00699-3>.