

From 2D to 3D: Advancing Diagnostic Devices with Quantitative Phase Contrast

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Background

Quantitative phase imaging (QPI) has become a significant approach that is transforming the understanding of cell physical characteristics and opening new possibilities for the development of cutting-edge diagnostic tools in oncology and hematology. Traditional diagnostic techniques sometimes rely on expensive and invasive procedures, while QPI offers a potential non-invasive and label-free approach for imaging living cells with remarkable precision.

Research Questions

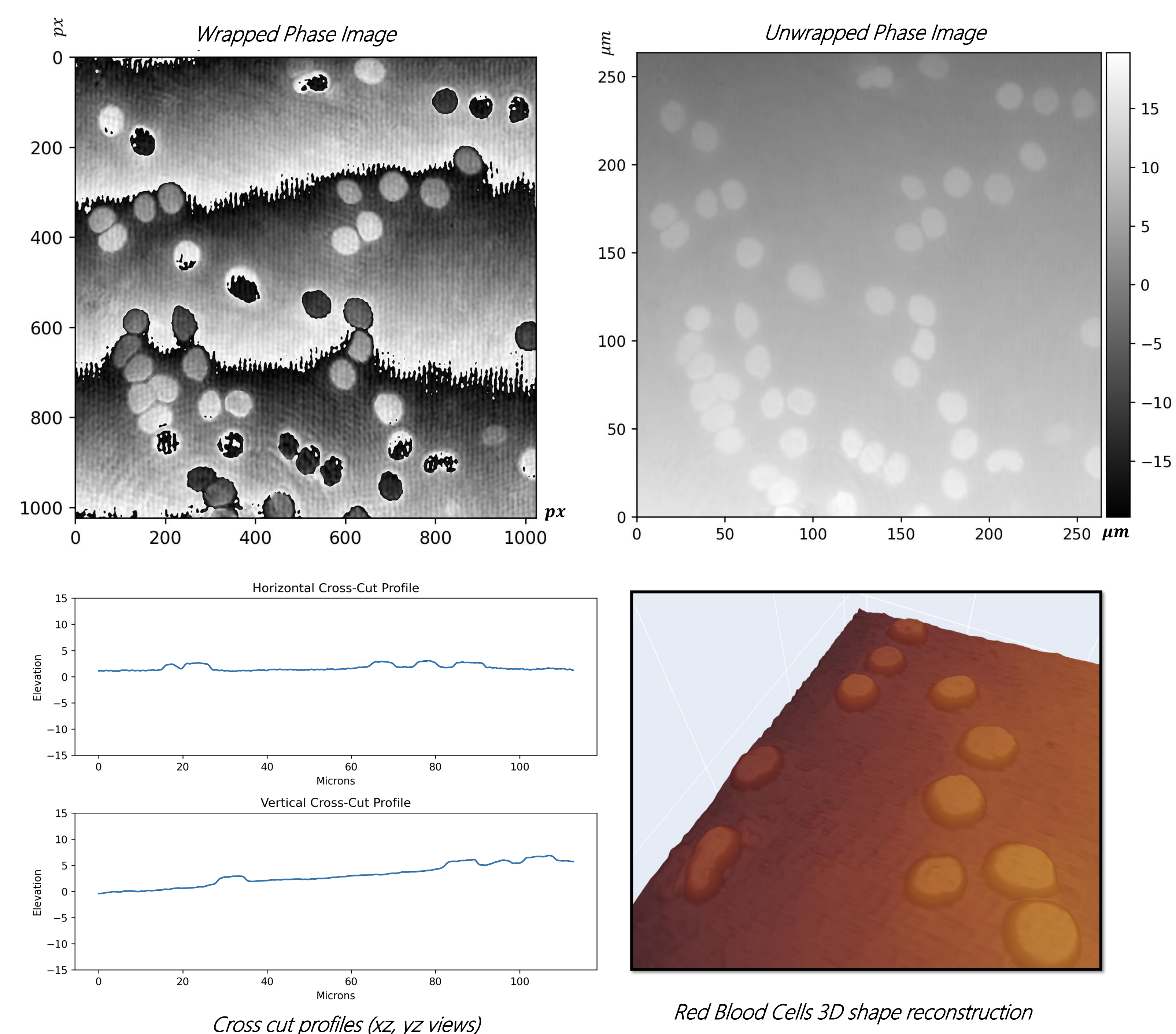
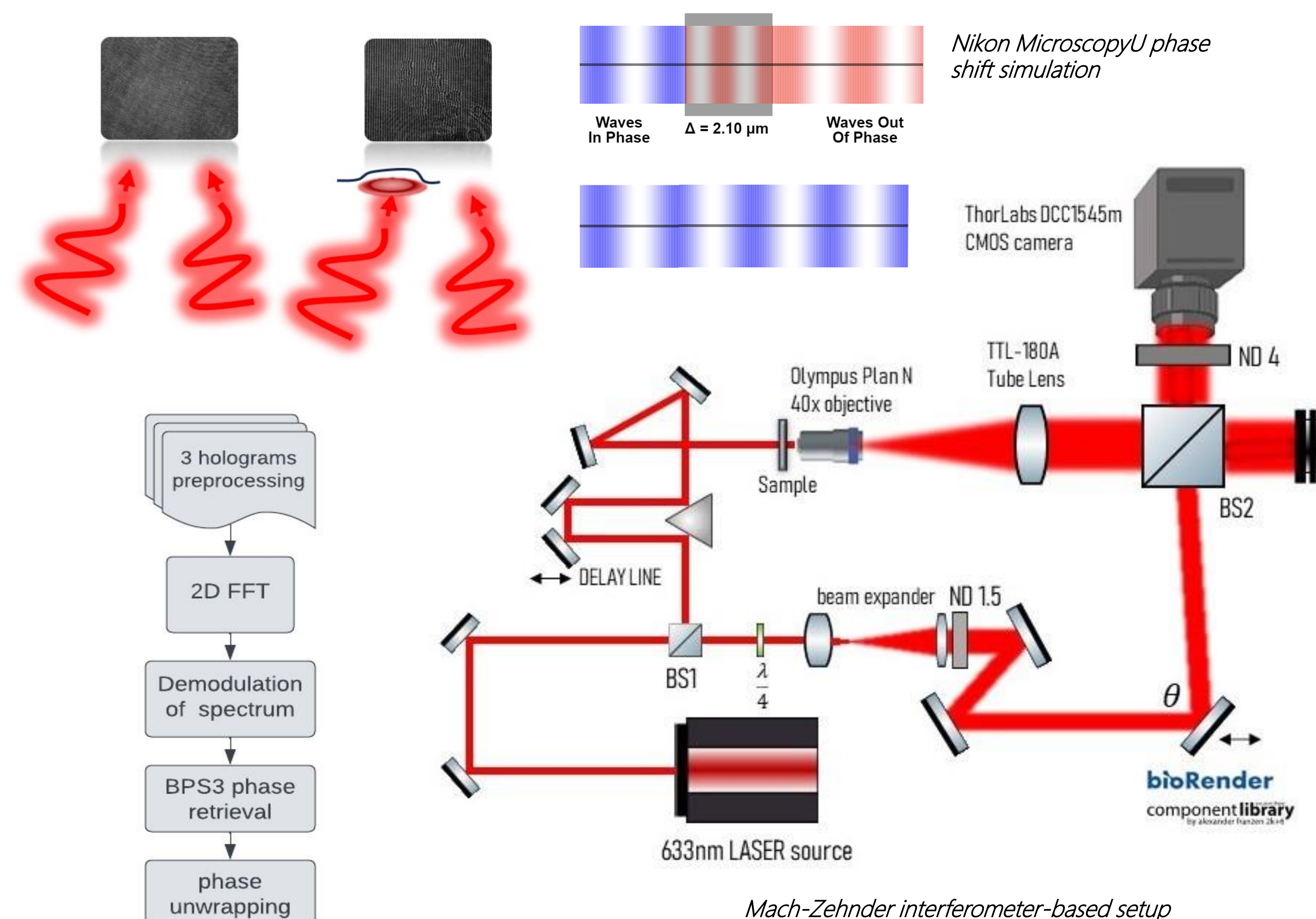
The primary goal of this study is to investigate how Quantitative Phase Imaging (QPI) may be used as a novel approach in the field of biomedical engineering for the development of next-generation diagnostic tools:

- What insights can QPI provide about cell characteristics?
- What potential improvements in diagnosis efficiency can be achieved?
- How does the choice of QPI method affect the quality of result?

Methods

In this study, RBCs' 3D shapes have been reconstructed using Digital Holographic Microscopy (DHM). A CMOS camera and Mach-Zehnder interferometer form the base of the data collection setup. The procedure is provided in the following order:

- Holograms acquisition
- Image pre-processing with Scikit Image
- Phase retrieval using the blind phase-shifting (BPS3) algorithm
- Phase unwrapping and post processing



Outcome(s)

QPI is capable of helping detect pathomorphological changes in cells based on changes in shape, refractive index, and density. Examples of application:

- Cell classification
- Cell counting for anemia detection
- Leukemia and Hemophilia detection and tracking

Conclusion

- Improvements in QPI have made it feasible to calculate the volumetric characteristics of cells and reconstruct their precise 3D shapes for use in diagnosis.
- In comparison with traditional DHM and HPM methods, the application of phase retrieval based on ML represents a new research direction with the potential to increase accuracy and processing efficiency.
- Future directions include exploring the applications of AI in real-time data processing for abnormalities recognition.

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