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A Survey of Non-Invasive Techniques and Artificial Intelligence Approaches for Blood Vessel Blockage Detection

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***Abstract*—Blood vessel blockage is one of the major causes of cardiovascular diseases worldwide. Traditional diagnostic methods such as angiography provide accurate results but are invasive, expensive, and may cause discomfort to patients. Recent advancements in medical signal processing, wearable sensors, machine learning, and artificial intelligence have enabled the development of non-invasive techniques for vascular health assessment.**

This survey reviews existing approaches including Photoplethysmography (PPG), Electrocardiography (ECG), Infrared Thermography, Ultrasound Imaging, Electrical Impedance Tomography (EIT), wearable healthcare devices, and AI-based diagnostic systems.

***Index Terms*—Blood Vessel Blockage, Non-Invasive Diagnosis, Artificial Intelligence, Machine Learning, PPG, ECG, Cardiovascular Disease**

I. Introduction

Blood vessel blockage is a serious medical condition that restricts normal blood flow through arteries and veins. If left untreated, it can result in heart attacks, strokes, and peripheral artery disease. Angiography is considered the gold standard for diagnosing arterial blockages; however, it is invasive, costly, and requires specialized medical facilities.

Recent developments in biomedical sensors, signal processing, and artificial intelligence have enabled the creation of non-invasive diagnostic systems capable of identifying vascular abnormalities without surgical procedures.

II. Literature Review

The literature indicates significant progress in non-invasive vascular diagnosis through signal processing, wearable sensors, and machine learning technologies.

TABLE I
Comparative Analysis of Existing Non-Invasive Blood Vessel Blockage Detection Systems

Sr.No.	Paper Title	Author(s)	Year	Key Contribution
1	Non-invasive Detection of Vascular Diseases Using Machine Learning	Kumar et al.	2021	Machine learning based PPG analysis for arterial blockage detection.
2	Photoplethysmography: A Novel Tool for Vascular Diagnostics	Allen J.	2007	PPG based monitoring of blood flow and vascular abnormalities.
3	Infrared Thermal Imaging for Peripheral Vascular Disorder Detection	Lahiri et al.	2012	Thermal imaging for vascular obstruction detection.
4	Electrical Impedance Tomography for Cardiovascular Applications	Adler et al.	2014	EIT based cardiovascular diagnosis.
5	Deep Learning for Cardiovascular Disease Prediction Using Wearable Signals	Rajpurkar et al.	2019	Deep learning based ECG and PPG analysis.

III. Methodology

The methodology adopted in this survey focuses on analyzing existing non-invasive techniques for blood vessel blockage detection. Various studies based on PPG, ECG, thermal imaging, ultrasound imaging, wearable sensors, and artificial intelligence are examined and compared.

The proposed smart diagnostic framework collects physiological signals using non-invasive sensors. Signal preprocessing removes noise and artifacts. Feature extraction techniques identify important cardiovascular indicators, which are then analyzed using machine learning algorithms to predict possible blood vessel blockages.

The generated results are compared with medical thresholds and used to estimate blockage severity and associated risks.

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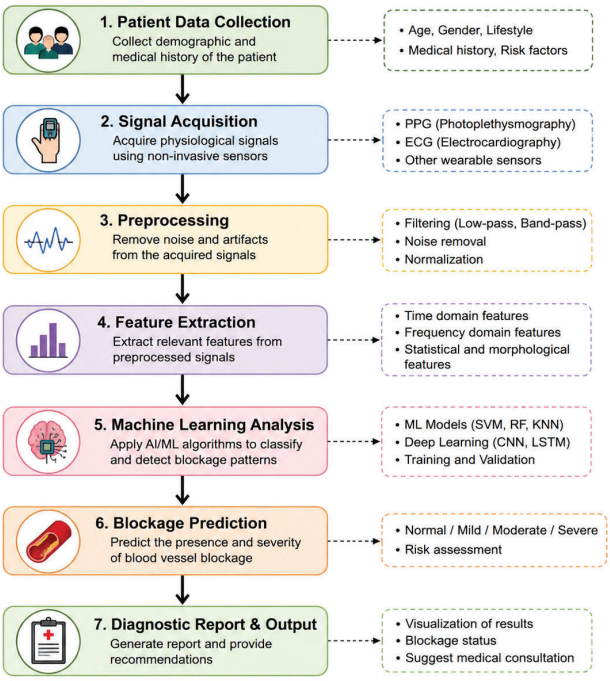

Figure: Methodology of Smart Diagnostic System for Blood Vessel Blockage Detection Using Non-Invasive Methods

Fig. 1. Methodology of Smart Diagnostic System for Blood Vessel Blockage Detection Using Non-Invasive Methods

IV. Research Gap

Although numerous non-invasive diagnostic techniques have been developed, most systems focus on a single sensing modality. Existing methods often require expensive equipment or expert interpretation. There remains a need for an integrated AI-based diagnostic framework that combines multiple physiological signals for accurate and affordable blood vessel blockage detection without angiography.

V. Comparative Analysis

Machine learning methods provide improved diagnostic accuracy, while wearable sensors enable continuous monitoring. Thermal imaging and EIT offer additional physiological insights. However, limitations such as cost, data availability, and interpretability still exist.

VI. Future Scope

Future research should focus on integrating wearable healthcare devices, cloud computing, Internet of Things (IoT) technology, and advanced deep learning models. Real-time monitoring and personalized risk prediction can significantly improve early diagnosis and patient care.

VII. Conclusion

This survey reviewed various non-invasive approaches for blood vessel blockage detection, including PPG, ECG, thermal imaging, EIT, and AI-based diagnostic systems. The analysis highlights the potential of intelligent healthcare technologies to provide early, cost-effective, and accessible cardiovascular diagnosis. Future developments are expected to further improve diagnostic accuracy and clinical adoption.

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