Extended Reality Heart Representation Driven by Real-Time IoT ECG Measurements

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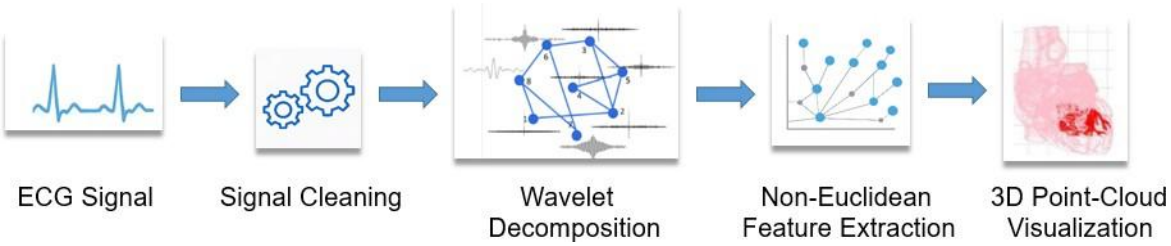
This work presents an XR Heart Twin system designed to bridge real-time physiological monitoring with immersive mixed reality visualization. Starting from ECG signals acquired from wearable IoT devices or loaded from publicly available datasets, the system processes cardiac waveforms through a multistage pipeline that includes signal cleaning, R-peak detection, multiscale wavelet decomposition, and extraction of non-Euclidean features. These features are used to generate a dynamic 3D point-cloud representation that models the temporal evolution of cardiac electrical activity, following the prototype developed in MATLAB. The architectural framework integrates IoT communication layers, lightweight middleware for data routing, and cloud-deployable microservices that handle computation and streaming. The resulting 3D heart activation model is then encoded as an animated sequence and delivered through a web interface optimized for Microsoft HoloLens, enabling holographic visualization directly within the user's environment. By combining biosignal analysis, advanced feature representation, and XR rendering, the system demonstrates a novel approach to multimedia signal processing for healthcare. It enables intuitive and spatially immersive exploration of cardiac dynamics, supporting potential applications in medical training, patient monitoring, affective computing, and interactive digital twin development. This prototype highlights the feasibility of integrating physiological sensing and XR technologies into a unified, responsive, and extensible platform.



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Reference

E. Fejzic, P. Udovicic, A. Silvi, S. Colonnese, Extended Reality Heart Twin from ECG IoT measurements, 13th European Workshop on Visual Information Processing, 13-16 October 2025, Valletta, Malta.