AI bracelet for health monitoring

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Definition of Heart Sclerosis (Cardiosclerosis)

- Heart sclerosis is a pathological condition characterized by the replacement of healthy heart muscle (myocardium) with fibrous or scar tissue

- Commonly results from: Myocardial infarction (heart attack), Chronic ischemia, Myocarditis (inflammation), Degenerative aging processes

- This scarring impairs the heart's mechanical and electrical functions, leading to serious clinical manifestations

Main Objective

- To develop an AI-powered system that can detect early signs of heart sclerosis using continuous, non-invasive physiological data collected from a smart bracelet.

- The system will analyze patterns in heart rate variability (HRV), pulse waveform morphology, activity levels, and other biosignals to identify anomalies associated with myocardial fibrosis.

Secondary Objectives

1. Develop software to collect and stream real-time sensor data from the smart bracelet (T-Watch S3 Plus + MAX30102 PPG sensor)

2. Conduct a pilot study to gather a dataset from volunteers (including healthy individuals and those with known cardiac conditions)

3. Train and validate an AI/ML model capable of flagging potential indicators of heart sclerosis based on wearable-derived metrics

4. Correlate clinical symptoms of cardiosclerosis with measurable biosignals from wearable sensors

Relevance & Societal Impact

- Early detection: Enables timely intervention before heart failure develops
- Accessibility: Non-invasive monitoring for at-risk populations (e.g., post-MI patients, elderly)
- Preventive healthcare: Continuous monitoring supports proactive management of cardiac health

Symptom–Sensor Correlation Table

Clinical Manifestation of Heart Sclerosis	Relevant Wearable Sensor(s)	Measurable Signal
Arrhythmias / Irregular heartbeat	PPG (MAX30102)	Heart rate variability (HRV), inter-beat intervals
Fatigue, reduced exercise tolerance	Accelerometer + PPG	Activity level, step count, HR recovery post-exertion
Shortness of breath (dyspnea)	Accelerometer + HR trends	Resting HR elevation, abnormal HR response to minimal activity
Conduction abnormalities (e.g., bradycardia)	PPG	Sustained low HR, pauses in rhythm
Fluid retention / nocturnal symptoms	Longitudinal HR & activity trends	Nighttime HR spikes, reduced sleep quality (indirect)

What We've Done This Week

Dataset Research & AI Development

- Conducted extensive research on publicly available PPG, HRV, and Accelerometer datasets.
- Identified a multi-tier strategy prioritizing Foundation Training PulseDB followed by Motion Artifact Handling PPG-DaLiA.
- Began setup and preprocessing of the PulseDB foundation dataset in parallel with hardware integration to maximize model training efficiency.
- Plan to transition to our own collected data once the wrist-worn hardware is operational to fine-tune the final classification model.

AI/ML DATASET STRATEGY

Category	Dataset	Size / Key Feature	Justification for Use
Foundation Training (Phase 1)	**PulseDB** (MIMIC-III/VitalDB Derivative)	**5,361 subjects / 5.2 Million** pre-cleaned 10-s segments of ECG, PPG, ABP.	**ML-Ready Baseline:** Used to train the initial feature extractor and the **first disease classifier** using linked MIMIC-III heart failure labels.
Motion Artifact Handling (Phase 2)	**PPG-DaLiA** + WESAD/WildPPG	**136+ subjects** with synchronized wrist PPG and 3-axis ACC.	**Noise Resilience:** Enables the implementation of synthetic augmentation to adapt the baseline model to the high motion noise of our wrist-worn device.
Disease Labels & Validation (Phase 3)	**MIMIC-III Derived Cohort** + Our Pilot Data	Clinical labels for **682 Heart Failure patients** and 954 controls.	**Ground Truth Proxy:** Provides a proven clinical endpoint Heart Failure as the best available proxy for detecting early-stage myocardial fibrosis.

IMPLEMENTATION ROADMAP: THE 3-PHASE PIPELINE

Phase	Focus & Goal	Key Task & Dataset(s)	Deliverable
Phase 1: Foundation & Classification (Current Focus)	**GOAL:** Establish the ideal feature extraction and initial disease detection logic.	Train on **PulseDB** and label a subset using the **MIMIC-III Derived HF Cohort**.	**Initial Disease Classifier & Feature Extractor**
Phase 2: Motion Artifact Handling	**GOAL:** Adapt the Phase 1 model for real-world wrist-worn usage.	Implement **Synthetic Augmentation** using ACC data from PPG-DaLiA.	**Motion Artifact Removal Module** (Model is now wrist-robust)
Phase 3: Final Validation & Deployment	**GOAL:** Test the motion-robust model against custom data and finalize performance metrics.	A) Collect **Our Pilot Data**. B) Fine-tune and validate against the **HF** cohort.	**Final Binary Classification Algorithm** for Heart Sclerosis Risk

Hardware Progress
T-Watch S3 Plus - Received & Setup in Progress

- Successfully received the T-Watch devices
- Configuring the built-in accelerometer for activity tracking and movement detection(in progress)
- Integrating external MAX30102 PPG sensor for heart rate monitoring (in progress)
- Sensor placement: Mounted on wrist underside (radial artery position) via I^2C connection with proper shielding and strain relief for 48-hour continuous wear (only on paper)

Power Management Solution
Extended Battery Life Strategy

•Challenge: Continuous WiFi transmission drains battery too quickly for 48-hour monitoring

•Solution: Local data storage on device memory during the entire monitoring period

•Data transfer: After 48 hours, patient uses WiFi to upload all collected data to server in one session

•Result: Bracelet operates for full 48 hours without recharging, ensuring uninterrupted diagnostic data collection