LifePulse

Real-Time IoT Heart Monitoring

An integrated approach to continuous health tracking and automated emergency response.

PROTOTYPE SPECIFICATION // ESP32 ARCHITECTURE

The Imperative for Continuous Monitoring

The Current Gap

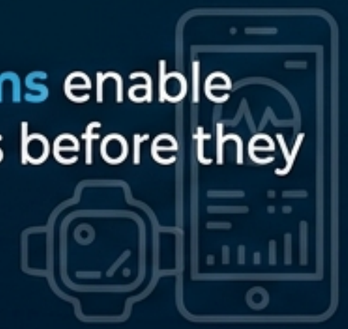
Cardiovascular health is a primary physical indicator, yet monitoring is traditionally restricted to clinical settings.

Standard hospital equipment is immobile, expensive, and reactive.

The IoT Solution

Advancements in **embedded systems** bridge the gap between periodic checks and continuous oversight.

Low-cost, real-time systems enable detection of abnormalities before they become emergencies.



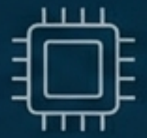
OBJECTIVE: Democratize access to early detection and timely intervention.

Introducing LifePulse

A comprehensive IoT monitoring system

MEASURE

Continuous sensing of pulse signals via optical sensor hardware.



ANALYZE

On-board calculation of BPM and real-time abnormality detection.

DISPLAY

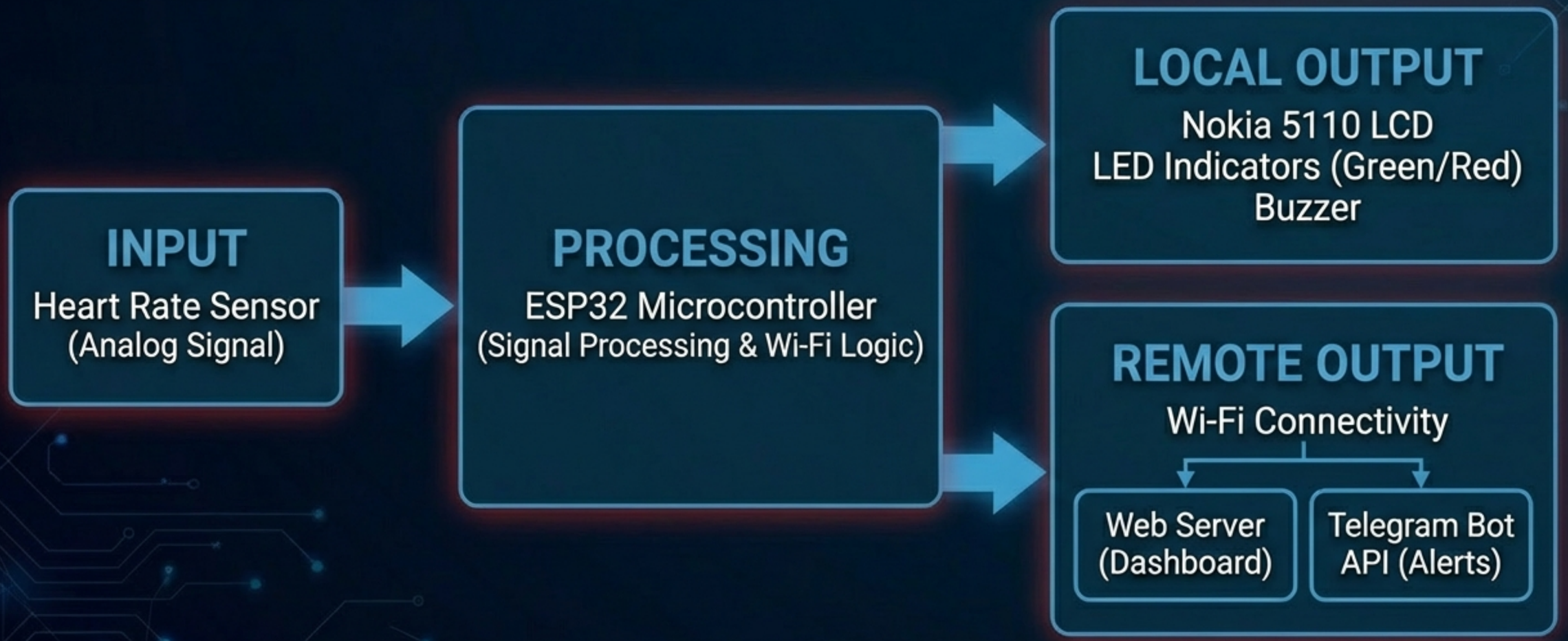
Immediate feedback via local LCD and remote Web Dashboard.

ALERT

Automated multi-channel warning system (Visual, Audio, Telegram).

System Architecture

From biological input to digital network.



Hardware Engineering

THE BRAIN: ESP32 Microcontroller
Dual-core processing power with integrated Wi-Fi capabilities.

THE INTERFACE: Nokia 5110 LCD
Low-power PCD8544 driver for legible local data output.

INDICATORS
Green LED (Normal) / Red LED (Alert >150 BPM) / Active Buzzer.

THE SENSOR: Pulse Sensor
Optical analog input detecting blood flow variance.

The Software Stack

Full-stack integration from embedded code to web interface.

FRONT-END INTERFACE

HTML • CSS • JavaScript

Responsive web dashboard • Real-time AJAX updates

CONNECTIVITY LIBRARIES

ESP32 Wi-Fi • WebServer.h • UniversalTelegramBot

Network stability • Local hosting • Secure messaging

EMBEDDED LOGIC

Language: Arduino C/C++

Sensor polling • Signal smoothing • Hardware interrupts

Methodology: Signal Processing

$$BPM = \frac{60000}{\Delta t}$$

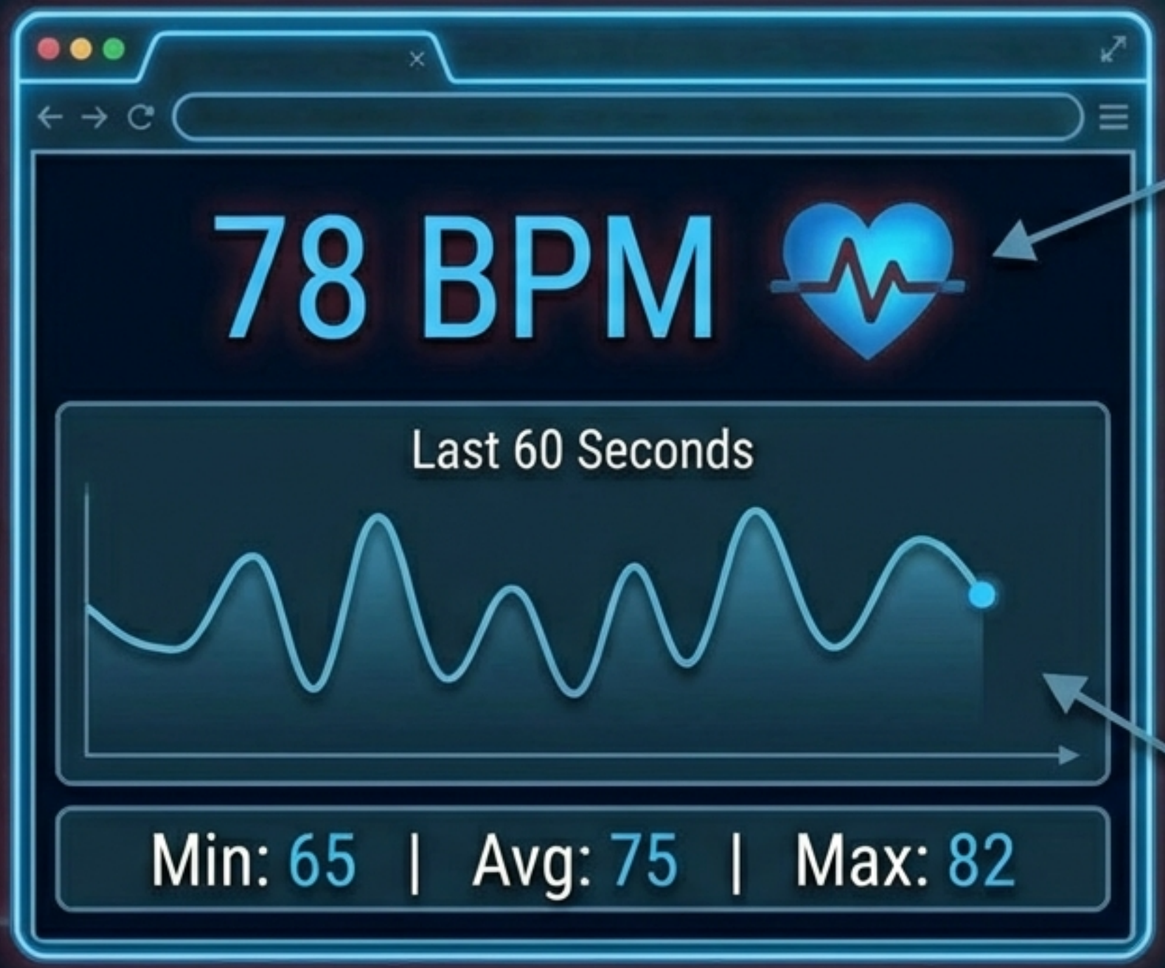
Where Δt is the time difference (ms) between consecutive rising edges.

Local User Interface

Status Logic	
Condition	**Action**
< 150 BPM	Display Rate, Green LED ON
> 150 BPM	Display Rate, Red LED ON, Buzzer PULSE

Remote Web Dashboard

Hosted directly on ESP32



Updates every second via REST API

Live historical trend visualization

Critical Safety Protocols

Automatic response to Critical Events (>150 BPM).

DETECTION

Algorithm confirms BPM > 150.

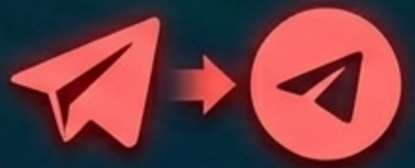
LOCAL ALARM

LED switches Green → Red. Buzzer activates.

PAYLOAD BUILD

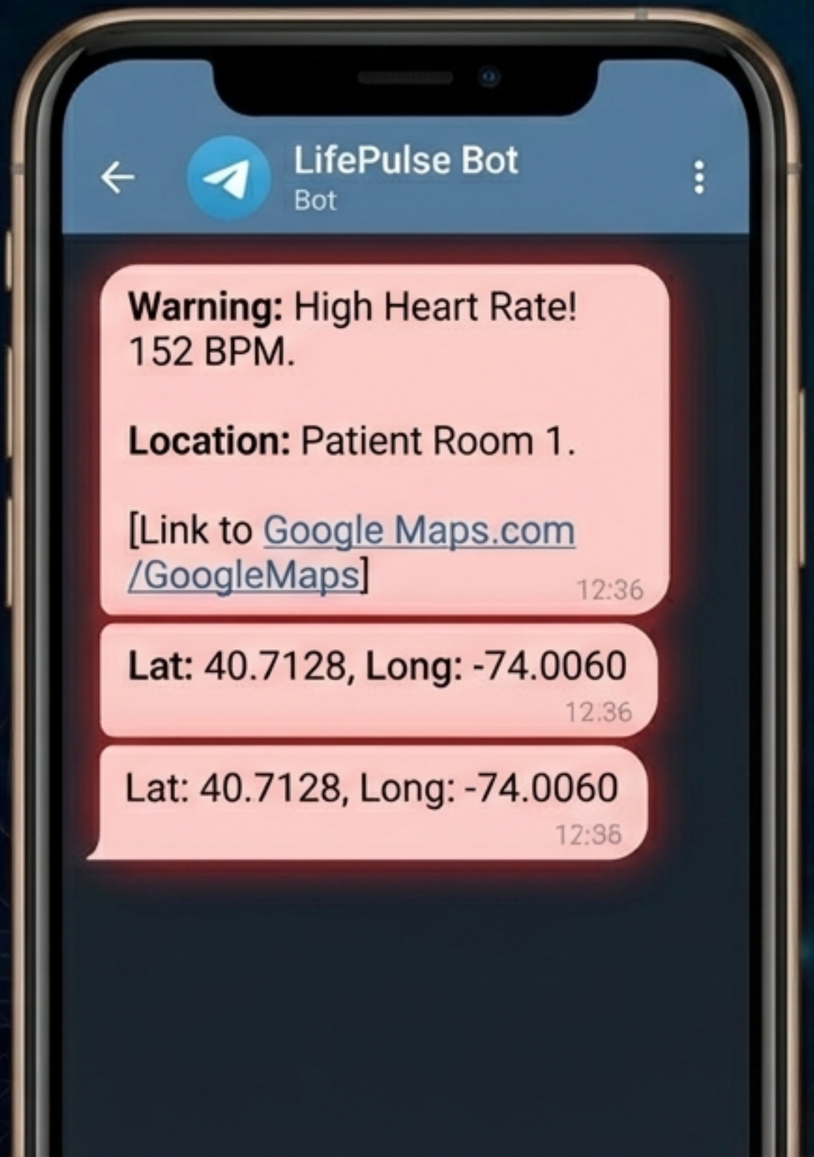
System captures BPM value and constructs warning text.

TRANSMISSION



Emergency notification dispatched via Telegram API.

Integrated Emergency Response



Why:

- **Push Notification:** Immediate delivery to caregiver devices.
- **Redundancy:** Ensures alerts are seen even if the dashboard is closed.
- **Location Aware:** Precise coordinates ensure responders know exactly where to go.

Results & Validation

Verification Checklist:

Metric	Observed Performance
Sensor Accuracy	Reliable beat detection and continuous measurement. ✓
Data Integrity	Log of 60-second history buffer with zero data loss. ✓
System Latency	Negligible delay suitable for real-time tracking. ✓
Alert Triggering	Immediate activation of LED, Buzzer, and Telegram API upon threshold breach. ✓

Discussion & Limitations

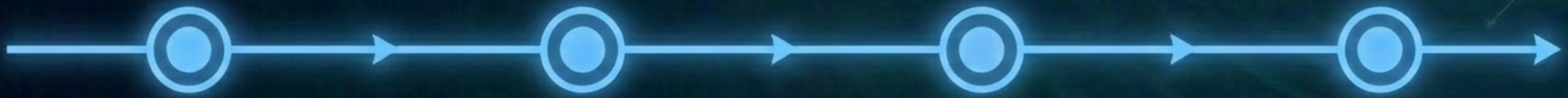
Project Successes

- Demonstrated high-utility monitoring with low-cost components.
- Successful integration of local hardware and cloud messaging.
- Open-source architecture.

Current Constraints

- **Fixed Location:** System currently relies on hardcoded location data rather than dynamic GPS.
- **Static Thresholds:** The 150 BPM trigger is constant and does not adapt to specific patient history or activity levels.

Future Roadmap



Hardware Evolution

Integration of dedicated GPS module for live tracking.

Advanced Sensing

Addition of SpO2 (Oxygen) and Temperature sensors.

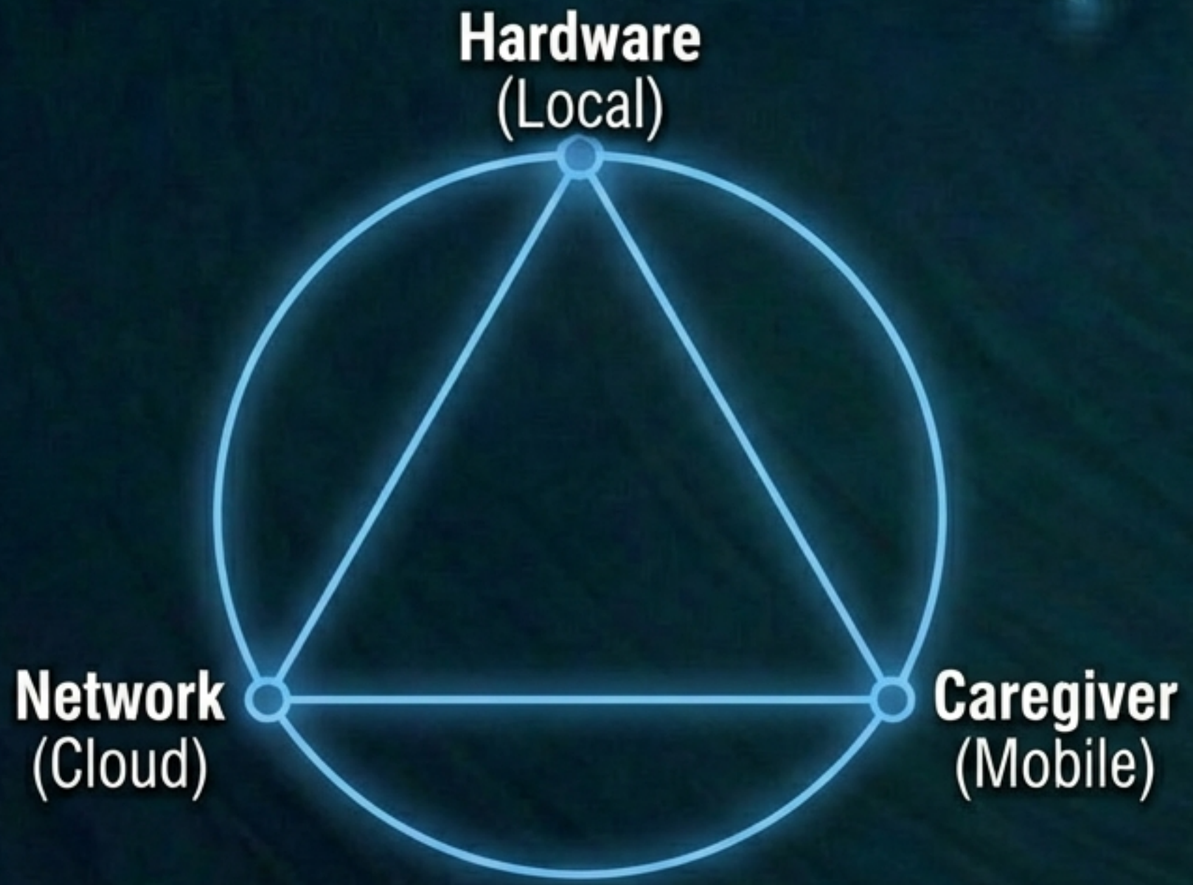
Intelligence

Machine Learning algorithms for arrhythmia pattern detection.

Ecosystem

Cloud storage for long-term history and mobile app development.

Democratizing Health Safety



LifePulse proves that effective health monitoring is accessible, affordable, and lifesaving. Scalable for schools, elderly care, and remote patient monitoring, it provides a proactive layer of safety through IoT innovation.

End of Pr