

Multi-Sensor System for Monitoring Acute Myocardial Infarction using Machine Learning

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17.65 million

Reported by the WHO in 2016

8.93 million
Cancer

2.38 million
Dementia

1.21 million
Tuberculosis

1.19 million
Kidney Disease

3.19 million
Diabetes

17.65 million

6.11 million
Respiratory Diseases

1.26 million
Liver Disease

1.03 million
HIV/AIDS

40%

Cardiovascular
Diseases (CVDs)



22%

Myocardial Infarction
(Heart Attack)

17%

Injuries

15%

Other NCDs

12%

Cancer

16%

Ischaemic Heart Disease

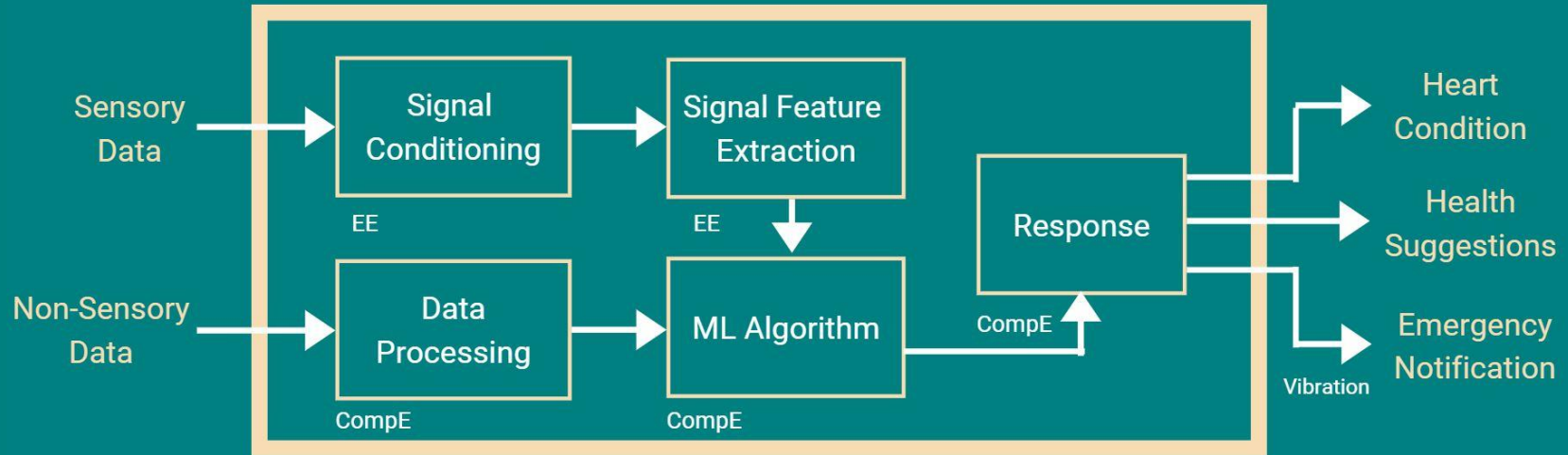
5%

Hypertension

Problem Definition

Awareness, early detection, and real-time monitoring of acute myocardial infarction (heart attack) through a wearable device within an intelligent system.

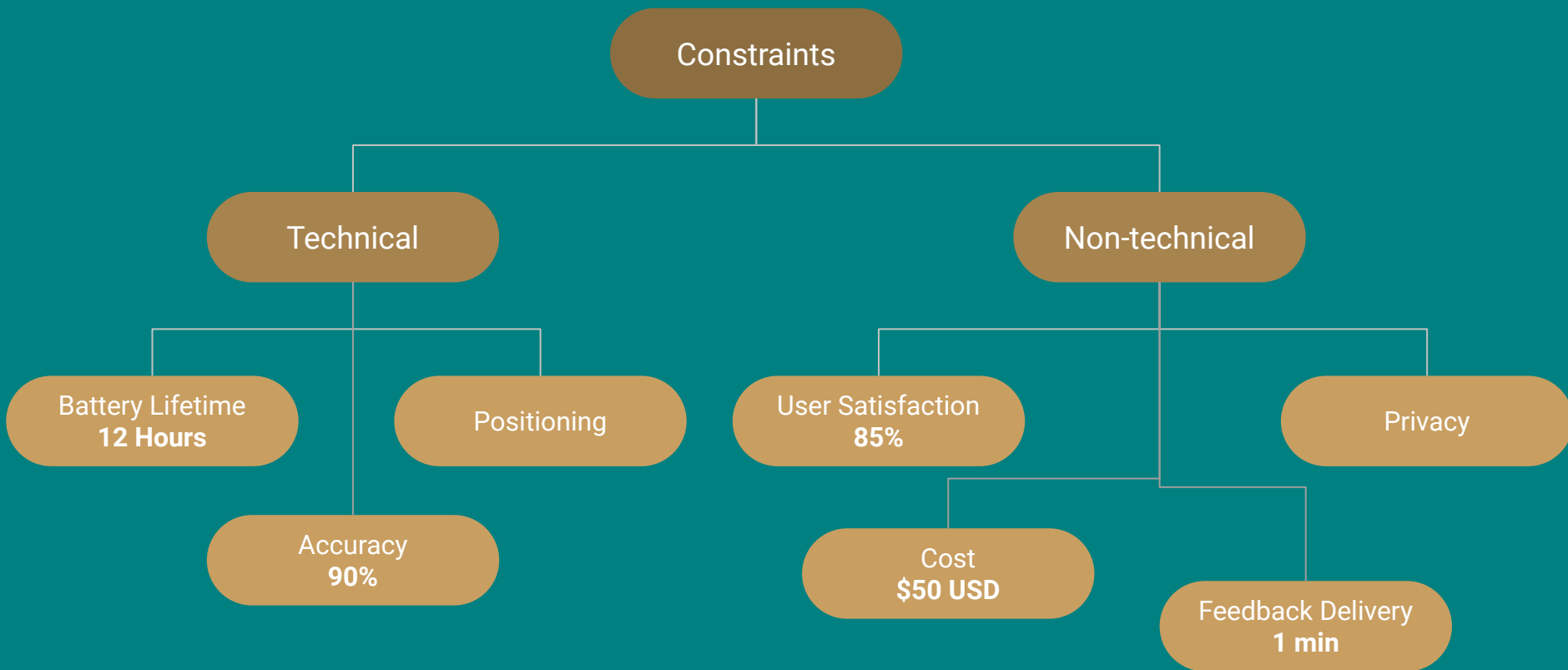
Heart Health Monitoring System



Project Breakdown

Hardware	Kai-Wen, Munib
Communication	Kai-Wen, Lujain, Munib
Machine Learning	Lujain

Design Constraints



Multiple Solution Concepts 1: Decision on Data Type

Clinical Diagnostic Guidelines

- Cardiac troponin
- Symptoms of myocardial ischemia
- ECG signal
- Imaging, angiography
- Heart rate
- Oxygen saturation rate

Risk Factors

- Age
- Sex
- Family history of CVDs
- Smoking
- Statin or Aspirin Therapy
- Obesity (High BMI)
- High cholesterol
- High blood pressure
- High blood sugar
- Stress

Selecting Solution Concept 1: Decision on Data Type

Criteria: High relevance to MI, technologically feasible, wearable, non-invasive

Final selection:

Sensory

- ECG signal
- Heart rate
- Oxygen saturation rate
- Blood pressure
- Activity

ECG sensor

Pulse Oximeter

Inertial Measurement Unit (IMU)

Non-Sensory

- Age
- Sex
- Family history of CVDs
- History of diabetes, smoking
- Statin or Aspirin Therapy
- Body mass index (BMI)
- Cholesterol levels (HDL, LDL, total)

Multiple Solution Concepts 2: Decision on Dataset

Data to be collected & analysed

- ECG signal
- Heart rate
- Oxygen saturation rate
- Blood pressure
- Age
- Sex
- Family history of CVDs
- History of diabetes, smoking
- Statin or Aspirin Therapy
- Body mass index (BMI)

Datasets Investigated

- Cleveland Heart Disease UCI
- US Government Health Datasets
- The Cardiovascular Research Grid
- Physionet CHARIS dataset
- World Health Organization datasets
- MIT-BIH Arrhythmia dataset

Selecting Solution Concept 2: Decision on Dataset

Criteria: relevant attributes present, size, completeness, literature available, multivariate

Final selection: Cleveland Heart Disease UCI dataset

Attributes to be used

- Resting ECG characterization
- Resting blood pressure
- Age
- Sex
- Smoking history

Output

- 5 classes
- 0 = no heart disease
- 1-4 = increasing presence of heart disease

ML problem specification:

- **By input:** supervised learning problem
- **By output:** classification problem

Overall Feedback specification:

- State of cardiovascular health in relation to myocardial infarction
- A recommendation to consult a doctor or change a lifestyle habit

Multiple Solution Concepts 3: Decision on **Device Placement**

- Balance between higher-fidelity ECG measurement areas and Pulse Oximeter measurement areas
- Minimization of movement discomfort and measurement noise and interference

Possible Placements

- Wrist
- Upper Arm
- Thorax
- Calf
- Ankle

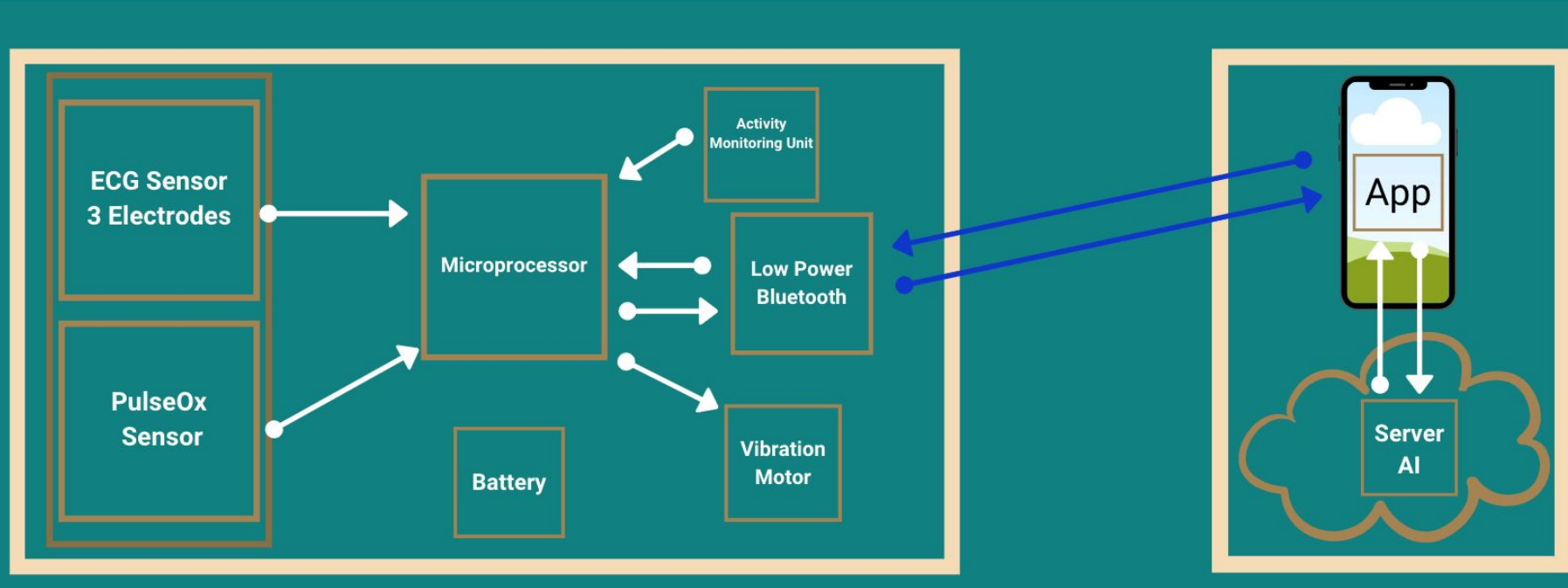
Selecting Solution Concept 3: Decision on Device Placement

Criteria: middle-ground optimization, discomfort/immobility minimization

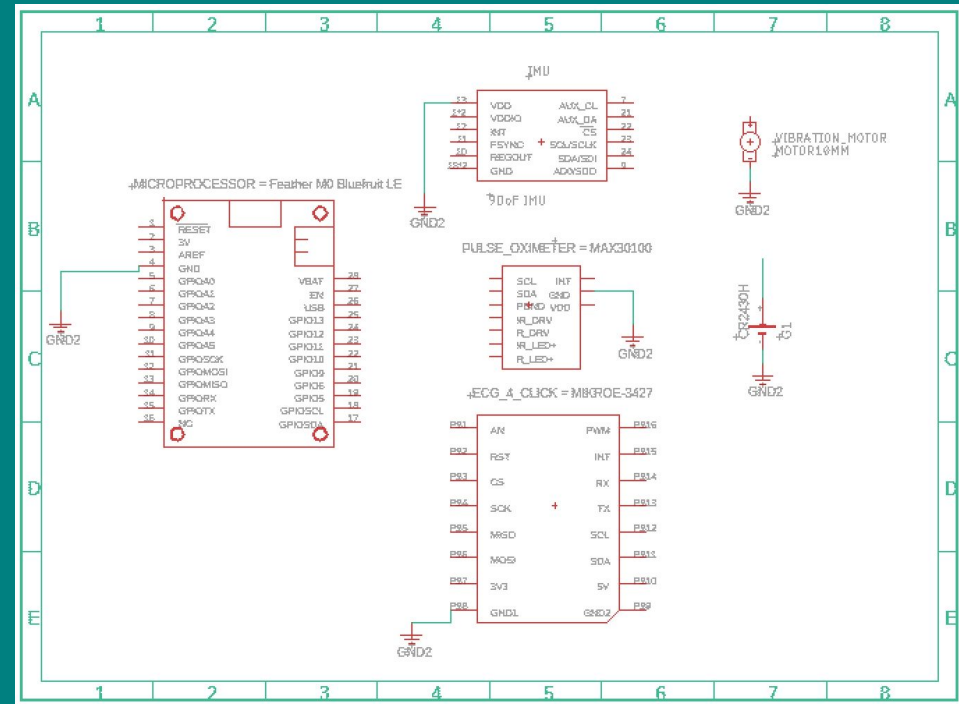
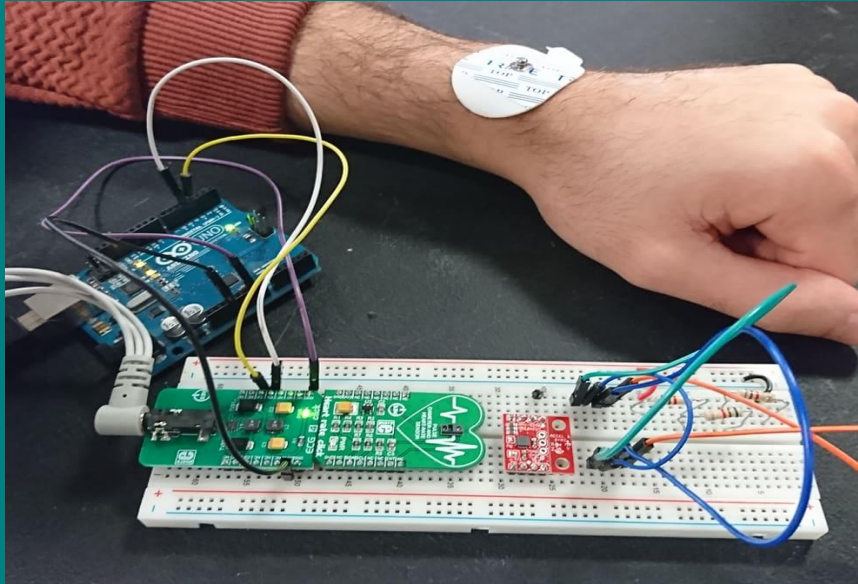
Final selection:

- Current placement on the upper arm as it gives both good ECG and Pulse Oximetry measurement
- Planning to experimentally test different placements and deduce the optimal positioning of the device

Preliminary System Design



Preliminary Prototype



Questions?