ECG Analyzer powered by EDGE IMPULSE

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- Atrial Fibrillation
- First Degree Heart block
- Normal
Increase in Fatality due to heart problems

- Rural areas without healthcare facilities
- Lack of awareness about cardiac arrest symptoms leads to fatality
- Increase in heart disease cases
Present ECG Analyzer machines in market and its features

- Present IoT Medical device sends bulk ECG data to the mobile/server and analysis is done in high processor / mobile App
- Computer based application which receives signals from ECG device and analyze the ECG patterns
- All the ECG analyzing device has dependency on Internet or high processing computers/ Mobile application.
Technology contribution

- ECG Analyzer powered by Edge Impulse will analyze the ECG data without any dependency on the Internet.
- Latency is lowest compared to IoT devices
- A 15Kb Rom - ECG Analyzing TinyML model can run on any TinyML supported microcontrollers.
- The device will analyze ECG patterns and classify into Normal, Atrial Fibrillation and First-Degree heart block
Architecture

Simulation

Matlab Signal builder

Normal ECG

Analog

Arduino Nano 33 Ble

Serial monitor

Datasets

Different ECG Data patterns

1st degree heart block

IRREGULARLY IRREGULAR (ATRIAL FIBRILLATION)

Normal ECG

ML Training

Datasets

ECG Analyzer

AD8232

Simulation

Datasets

Analog

Arduino Nano 33 Ble

Serial monitor

Datasets

Different ECG Data patterns

1st degree heart block

IRREGULARLY IRREGULAR (ATRIAL FIBRILLATION)

Normal ECG

ML Training

Datasets

ECG Analyzer
ECG Wave

- P Segment
- PR Interval
- QRS Complex
- ST Segment
- QT Interval
Complications

- If a clot breaks off, enters the bloodstream and enters into the brain, it will cause stroke. About 15–20 percent of people who have strokes have this heart arrhythmia.
- Heart failure – Heart loses the capacity to pump the required amount of blood
Complications

• First-degree AV block may be at an increased risk of Atrial fibrillation Heart failure
Simulating different ECG patterns using Matlab signal builder
Editing the ECG signals
Matlab Signal builder

ECGAnalyzer.c

Modified ECG signal data

Export using m script

Copy, Paste the data buffer

ECGAnalyzer.c
Challenge in Improving Prediction Accuracy

Normal

Atrial Fibrillation

AV Block1
Converting human observations into a new signal

When a doctor or trained person try to analyze the ECG graph, they will be counting the small boxes between R to R wave, P to R interval and write it down the counts in the graph or memories it for calculation.
<table>
<thead>
<tr>
<th>Condition</th>
<th>Human Observation</th>
<th>ECG Analyzer datasets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>observes boxes in graph and find no deviations</td>
<td>R-R Interval value: 100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PR Interval value: 50</td>
</tr>
<tr>
<td>Atrial Fibrillation</td>
<td>Observation: Boxes count in graph varies between two <strong>R R intervals</strong></td>
<td>R-R Interval value: -100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PR Interval value: 50</td>
</tr>
<tr>
<td>First-Degree Heart Block</td>
<td>Observation: Boxes count in graph between <strong>P to R</strong> indicates <strong>&gt;200ms</strong></td>
<td>R-R Interval value: 100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PR Interval value: -50</td>
</tr>
</tbody>
</table>
Normal ECG

No drop in R-R Interval

No drop in PR Interval

Atrial Fibrillation

Drop in R-R Interval
First-Degree Heart Block
Training Datasets

- Classes: 3 (Atrial Fibrillation, First-Degree Heart Block, Normal)
- Window length: 3000 ms.
- Window increase: 2999 ms.
- Training windows: 137

Feature explorer (137 samples)
Outcome
Library Portability

ECG Sensor → Any Microcontrollers + ECGAnalyzer lib → ECG Datasets → ECG Analyzer
1 Minute 30 seconds Demo session
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Automated TinyML

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Create tiny models, ready for embedding, in just a few clicks!

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Optimized models for embedded
Optimized low-level NN libraries
(i.e. CMSIS-NN)
RTOS such as Mbed OS
Arm Cortex-M CPUs and microNPUs

Application
Optimized models for embedded
(e.g. TensorFlow Lite Micro)
Runtime

Connect to high-level frameworks
Supported by end-to-end tooling
Connect to Runtime

Stay Connected
@ArmSoftwareDevelopers
@ArmSoftwareDev

Resources: developer.arm.com/solutions/machine-learning-on-arm
TinyML for all developers

- **C++ library**
- **Arduino library**
- **WebAssembly**

**Dataset**
- Acquire valuable training data securely
- Enrich data and train ML algorithms

**Edge Device**
- Real sensors in real time
- Open source SDK
- Embedded and edge compute deployment options

**Impulse**
- Test impulse with real-time device data flows

**Test**
- Acquire valuable training data securely
- Enrich data and train ML algorithms

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- Reinforcement learning for decision making

A platform to scale AI across the industry
Syntiant Corp. is moving artificial intelligence and machine learning from the cloud to edge devices. Syntiant’s chip solutions merge deep learning with semiconductor design to produce ultra-low-power, high performance, deep neural network processors. These network processors enable always-on applications in battery-powered devices, such as smartphones, smart speakers, earbuds, hearing aids, and laptops. Syntiant's Neural Decision Processors™ offer wake word, command word, and event detection in a chip for always-on voice and sensor applications.

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