Bringing Mobile Health to the Underdeveloped World

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Motivation

- Imagine a pregnant woman living in rural South Sudan, hundreds of miles away from the nearest medical center. A device that can continuously track her vital signs and tell her if she needs to get to a doctor could mean life or death for her and her unborn child.
- Existing wearables such as Apple Watch allow users to track their health status around the clock. However, in the context of the under-developed countries where people may earn less than 2 US dollars a day, these wearable devices are still pricey.

Project Description

- **Goal**: Develop an ultra-low-cost (e.g., 5-10 US dollars) wearable device that can track the user's vital signs continuously.
- **Design target I**: Affordable to the impoverished people living in underdeveloped countries.
- **Design target II**: Support fine-grained physiological activity sensing (e.g., heart rate, breath rate, and even heart sound).
- **Design target III**: User-friendly with extremely low power consumption.

Potential impact

- This project tries to bring mobile health to the world's poorest by proposing an ultra-low-cost wearable device.
- It represents an important research endeavor to push wearable technology for social good.
- The developed solutions will lead to considerable advancements in both low-power hardware designs and efficient vital sign sensing algorithms.

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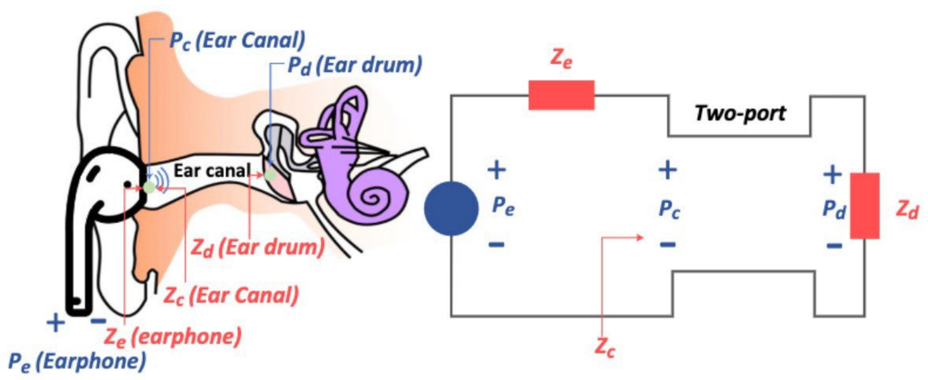
This project aims at designing a low-cost wearable device that is not just nice to have but that the underdeveloped world needs to have.

System Design

- **Observation**: the vital signs such as heartbeat signal propagate through the human body, arriving at the ear canal.
- **Basic idea**: we transform the speaker on those ultra-low-cost earphones into a "microphone" and use it to capture these vital signs in the user's ear canal.
- **Theoretical model**:

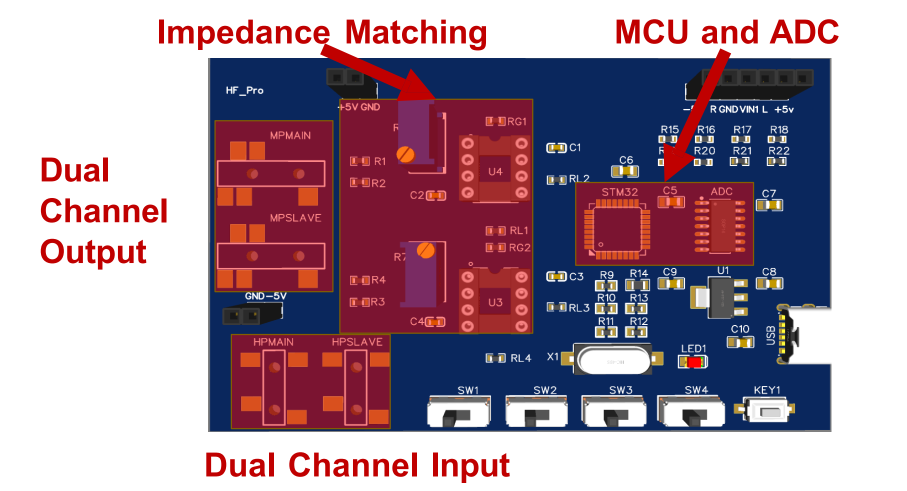
$$\frac{P_c}{P_e} = \frac{Z_c}{Z_c + Z_e} \Rightarrow Z_e = \frac{P_e Z_c}{P_c} - Z_c$$



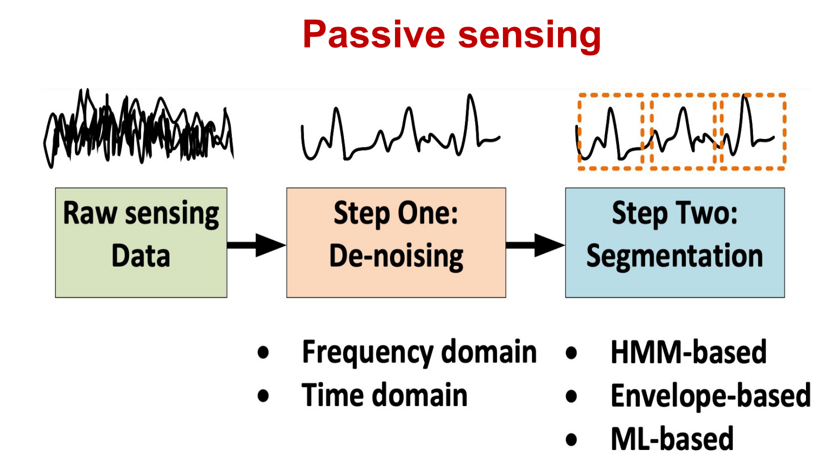
Technical Roadmap

Hardware-software codesign

- **On the hardware side:** we seek to minimize cost and power consumption while offering adequate computation and memory resources to process the raw samples.



- **On the software side:** we seek to detect the subtle physiological signals from the noisy samples.



Project Deliverables

- An end-to-end, low-cost wearable device.
- Open-sourced hardware and software.