Pediatric Neuromotor Wearable

Carl Demolder

Date 8/03/2020

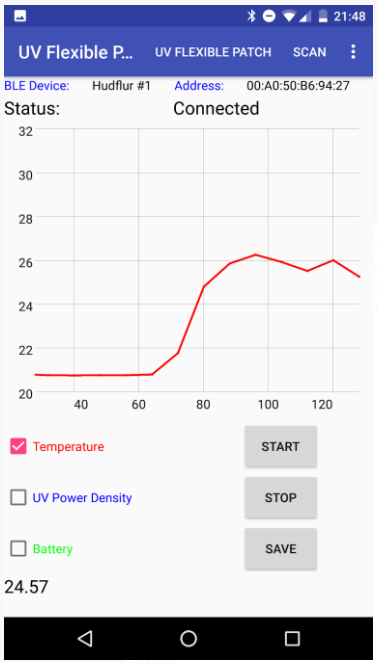
Outline

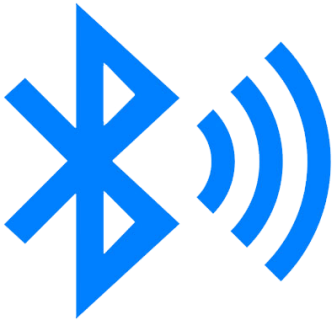
- Project management
  - Introduction
  - Project requirements
- Project proposal
  - Block diagram
  - Schematic
  - PCB design
  - Firmware
- Schedule
  - Gantt chart

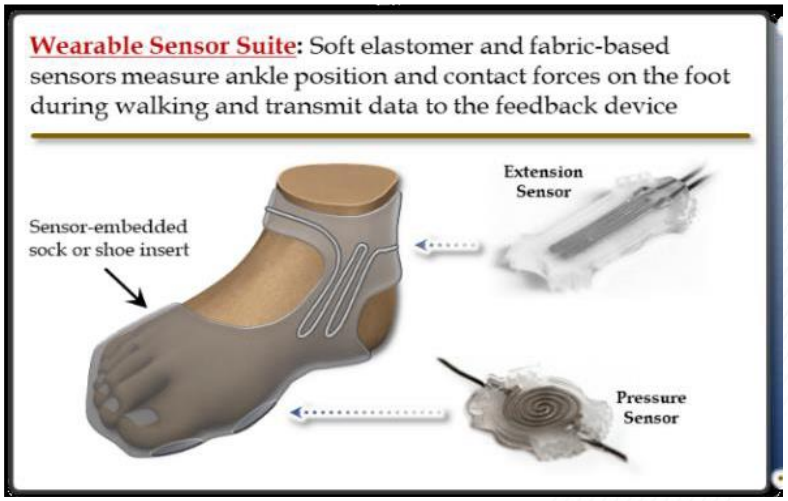
PROJECT MANAGEMENT

Introduction

- Purpose:
  - Design a wearable with sensors to measure temperature, pressure, strain, and movement. This data will be wirelessly transmitted via BLE to a UI band







Georgia Tech
CREATING THE NEXT

Project requirements

- Requirements:
  - Design a flexible circuit to use sensors to wirelessly communicate biophysical data to a UI band
  - Flexible circuit must include the following functionality:
    - Wireless charging
    - Battery management
    - RTT data logging
    - Use the nRF52832 MCU/SoC
    - BLE connectivity and BLE GATT database
    - Temperature sensing
    - Motion sensing
    - Pressure sensing
    - Strain sensing

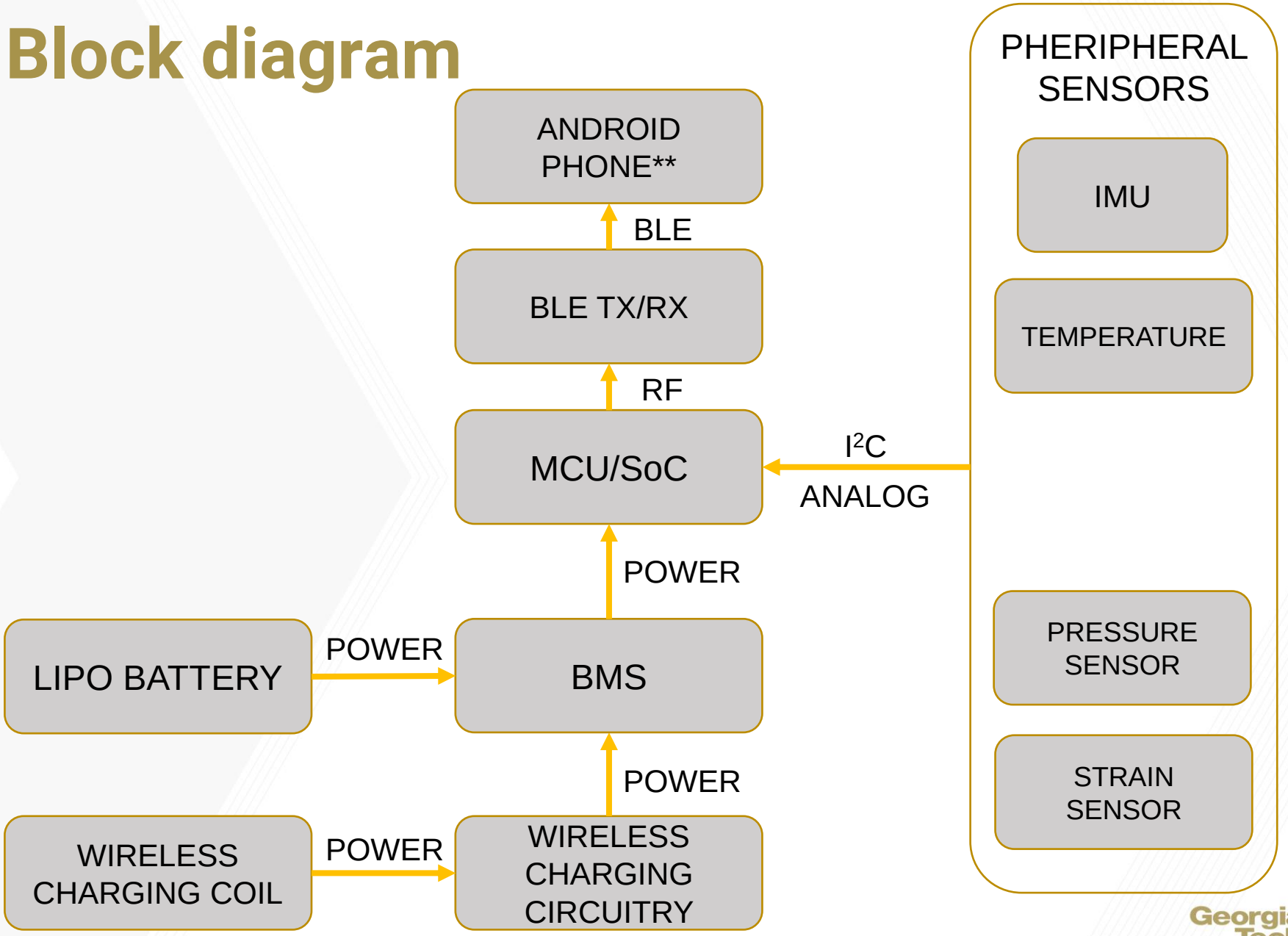
Schedule overview

- Electronics development
  - Date range: 8/11–8/23
  - Estimated hours to produce hardware: 24 hours
  - Estimated hours to test/debug/qualify hardware: TBD
- Firmware development
  - Date range: 8/23-9/20
  - Estimated hours to produce firmware: 39 hours
  - Estimated hours to test/debug/qualify firmware: TBD

PROJECT PROPOSAL

Georgia Tech
CREATING THE NEXT

Block diagram



Georgia Tech
CREATING THE NEXT

Electronics development: schematic

- Schematic generation
  - ~~nRF52 with supporting circuitry (2 hours)~~
  - ~~BLE antenna and impedance matching circuit (2 hours)~~
  - ~~Wireless charging (5 hours)~~
  - ~~Lithium battery charging (2 hours)~~
  - ~~Biosensors: temperature, IMU (4 hours)~~
  - Biosensors: pressure, strain (4 hours)
  - Test points (1 hours)
  - Project creation (3 hours)
- Estimated time: 8 hours
- Actual time spent: TBD

REUSING DESIGN FROM PREVIOUS PROJECTS

Georgia Tech
CREATING THE NEXT

Electronics development: PCB design

- PCB design
  - Major component layout (4 hours)
  - ~~BLE antenna and impedance matching circuit (3 hours)~~
  - Wireless charging (2 hours)
  - Lithium battery charging (1 hours)
  - Overall board construction(1 hour)
  - Biosensors: temperature, IMU, pressure, strain (3 hours)
  - Test points (1 hours)
  - Gerber file generation (2 hours)
  - BOM generation (2 hours)
- Estimated time: 16 hours
- Actual time spent: TBD

Georgia Tech
CREATING THE NEXT

Firmware development

- Firmware
  - Project and BLE stack (5 hours)
  - Sensor drivers
    - ~~I^2C driver (4 hours)~~
    - ~~Temperature driver (2 hours)~~
    - Analog driver (3 hours)
    - ~~IMU driver (3 hours)~~
  - ~~RTT data logging (3 hours)~~
  - BLE GATT database and data transfer (31 hours)

REUSING CODE FROM PREVIOUS PROJECTS

Georgia Tech
CREATING THE NEXT

SCHEDULE

Georgia Tech
CREATING THE NEXT

Schedule Gantt chart

Task	8/2-8/9	8/9-8/16	8/16-8/23	8/23-8/30	8/30-9/6	9/6-9/13	9/13-9/20
ELECTRONICS DEVELOPMENT							
-SCHEMATIC GENERATION							
-PCB LAYOUT AND ROUTING							
-HARDWARE DEBUGGING							
FIRMWARE DEVELOPMENT							
-PROJECT STACK ORGANIZATION							
-SENSOR DRIVERS							
-BLE GATT & BLE DATA TRANSFER							
-FIRMWARE DEBUGGING							

PATH FORWARD

Georgia Tech
CREATING THE NEXT

Path forward (8/02/20 – 8/09/20)

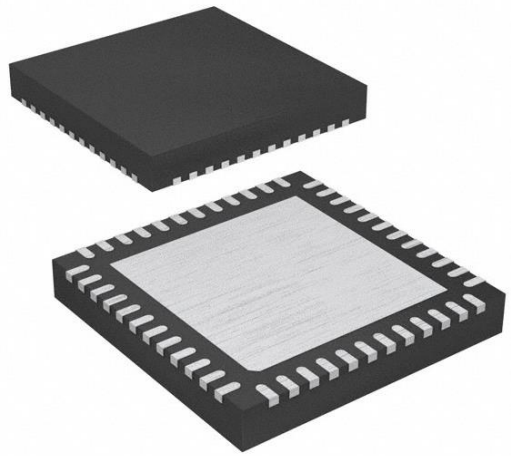
- Schematic generation
  - Wheatstone bridge
- PCB layout

APPENDIX

Georgia Tech
CREATING THE NEXT

Component selection: MCU/BLE

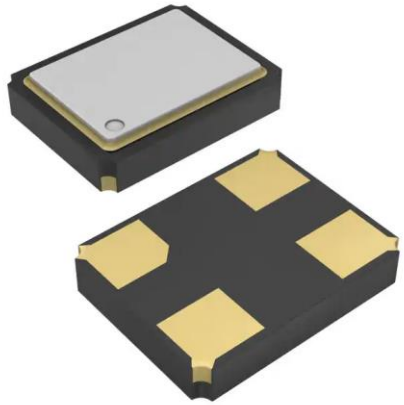
- MCU/BLE: nRF52832
  - 6 pin, 2.00 mm x 2.00 mm, WSON-6
  - ±0.1°C from -20°C to +50°C
  - 2.4 GHz BLE
  - Power = 4 dBm
  - Sensitivity = -96 dBm
  - RAM = 64 kB, flash = 512 kB
  - Serial interfaces: I^2C, UART, SPI
  - Supply voltage: 1.7V ~ 3.6V
  - $5.46 [X1], 1490-1067-1-ND, LINK



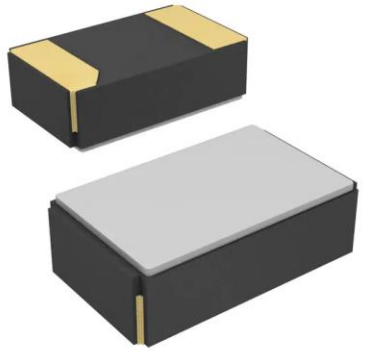
nRF52832

Component selection: clocks

- HF clock: US3200005Z
  - 4 pin, 1.60 mm x 1.20 mm, 4-SMD
  - 32.00 MHz, 8 pF, ±10 ppm
  - $1.45 [X1], US3200005ZCT-ND, LINK
- LF clock: ECX-1210
  - 1210 package, 1.20 mm x 1.00 mm, 2-SMD
  - 32.7680 kHz, 9 pF, ±20 ppm
  - $1.52 [X1], XC2283CT-ND, LINK



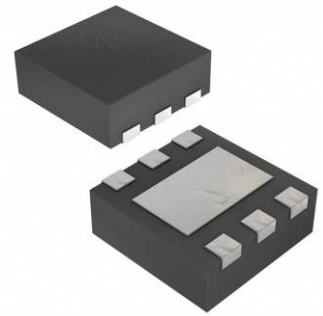
US3200005Z



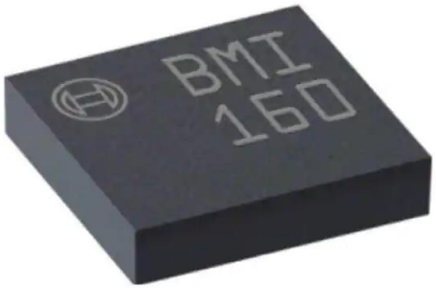
ECX-1210

Component selection: Bio-sensors

- Temperature: TI TMP117
  - 6 pin, 2.00 mm x 2.00 mm, WSON-6
  - ±0.1°C from -20°C to +50°C
  - 16-bit resolution: 0.0078 °C, I^2C
  - $8.02 [X1], 296-51834-1-ND, LINK
- IMU: TI BQ27621-G1
  - 14 pin, 2.5 mm x 3.0 mm, 14-LGA
  - I^2C communication
  - 9-axis, 16-bit resolution
  - Full operation mode = 925 uA
  - $4.98 [X1], 828-1057-1-ND, LINK



TMP117



BMI160

Component selection: Bio-sensors

- Pressure & Strain: LMV981
  - 6 pin, 1.5 mm x 1.3 mm, 6-DSPGA
  - Differential Amplifier, I^2C
  - $1.63 [X2], LMV981, LINK

LMV981

Component selection: wireless charging

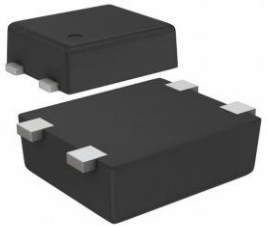
- Wireless charging IC: TI BQ51003
  - 28 pin, 1.90 mm x 3.00 mm
  - QI v1.2 communication protocol
  - 93% AC-DC efficiency
  - $3.00 [X1], 296-39952-1-ND, LINK
- LiPo battery charger IC: TI BQ25100
  - 6 pin, 1.6 mm x 0.90 mm, 4.2V 1 cell
  - 1% Charge voltage accuracy
  - 10 mA to 250 mA charging current
  - $2.24 [X1], 296-38373-1-ND, LINK

BQ51003

BQ25100

Component selection: power circuit

- Reed Switch: ABLIC S-5712A
  - 4 pin, 1.90 mm x 3.00 mm, SNT-4A
  - Non-contact ‘power switch’
  - High accuracy hall effect switch IC
  - $1.07 [X1], 1662-1617-1-ND, LINK



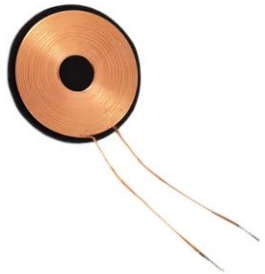
S-5712A

- Linear Regulator: Analog Devices ADP172
  - 4 pin, 0.95 mm x 1.03 mm, 4-WLCSP
  - 0.1V dropout voltage
  - 300 mA max current
  - $1.09 [X1], ADP172ACBZ-3.0-R7CT-ND, LINK

ADP172

Component selection: power circuit

- Charging coil: Wurth 760308101219
  - 1 coil, 1 layer, D=15 mm, H=0.6 mm
  - 11.8 uH, 750 mΩ, t = ±10%
  - $7.43 [X1], 732-9675-ND, LINK



760308101219