

Wearable Pediatric Eczema Tracker | Team 23

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INTRODUCTION

Objective:

Eczema, also known as atopic dermatitis, is one of the most widespread skin conditions affecting nearly 20% of the world population and is more common and severe to young children and infants. Its main symptoms are severe itching and skin cracking which eventually damages the skin. Until this day there is no known universal cure and what dermatologists suggest is to find the “triggers” which may involve consumed food, environmental exposures, or chemicals and to isolate the patient from it. The biggest problem is that it is nearly impossible to track down such triggers as symptoms of itchy skin rash may arise long after 24-48 hours from making contact, and since infants and children have limited means to convey their symptoms objectively for dermatologists to diagnose. There should be a viable alternative for such people in need.

Background

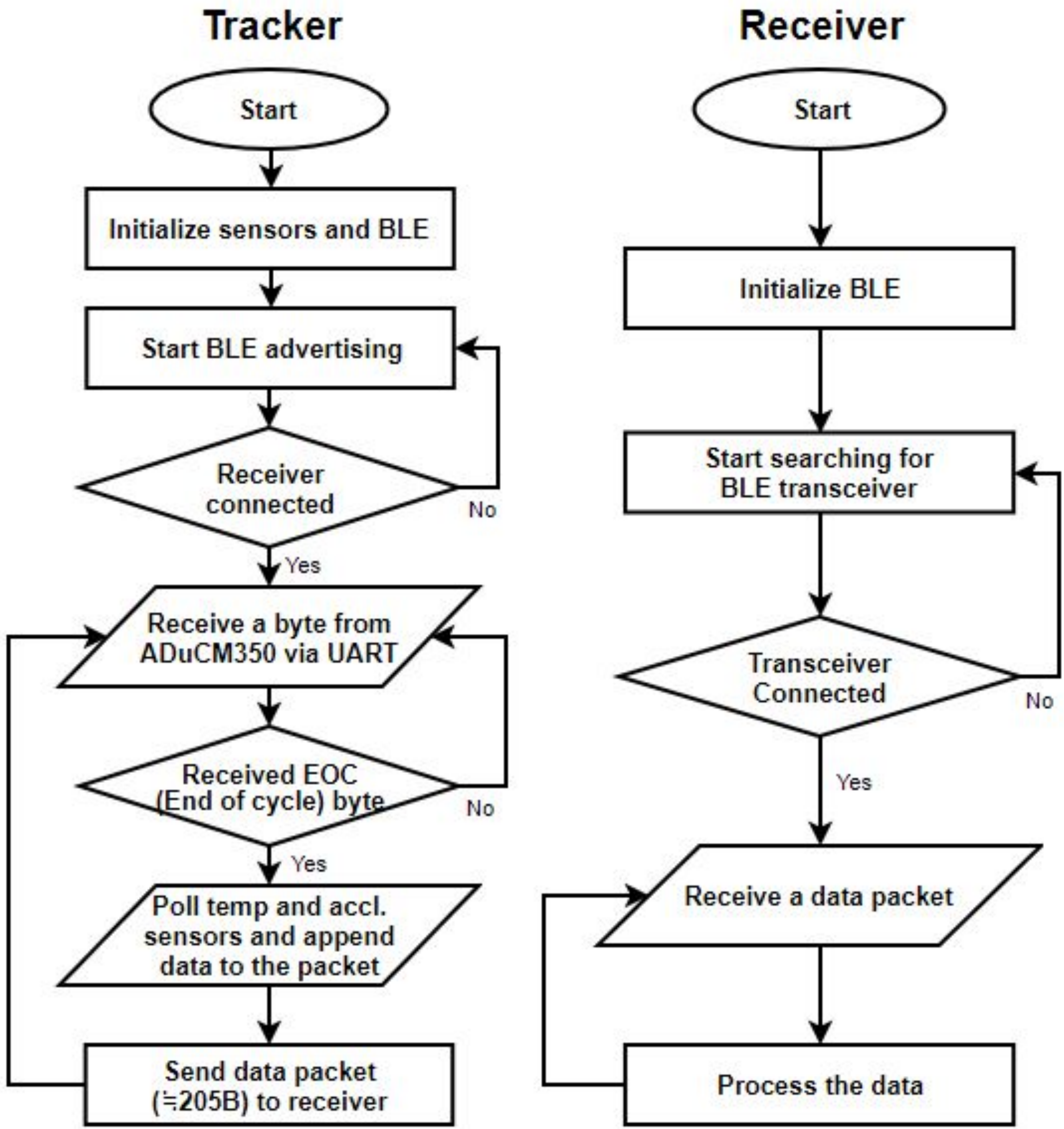
As of 2019, there are numerous solutions to bookkeep and track the frequency of eczema flare-ups through smartphone applications. These applications provide daily tracking through manually logging scores on the severity of the patient’s pruritus. However, there is still no known sensory-device based solution that provides an objective metric of pruritus. Moreover, this problem is pronounced for the pediatric population as indicated by several works of literature: “Because currently available tools to assess parental and patient reports of sleep disruption and itching correlate poorly with measures, objective studies are critical for the assessment of sleep disturbances in children with AD”.

AIM

Low Cost Eczema Tracker

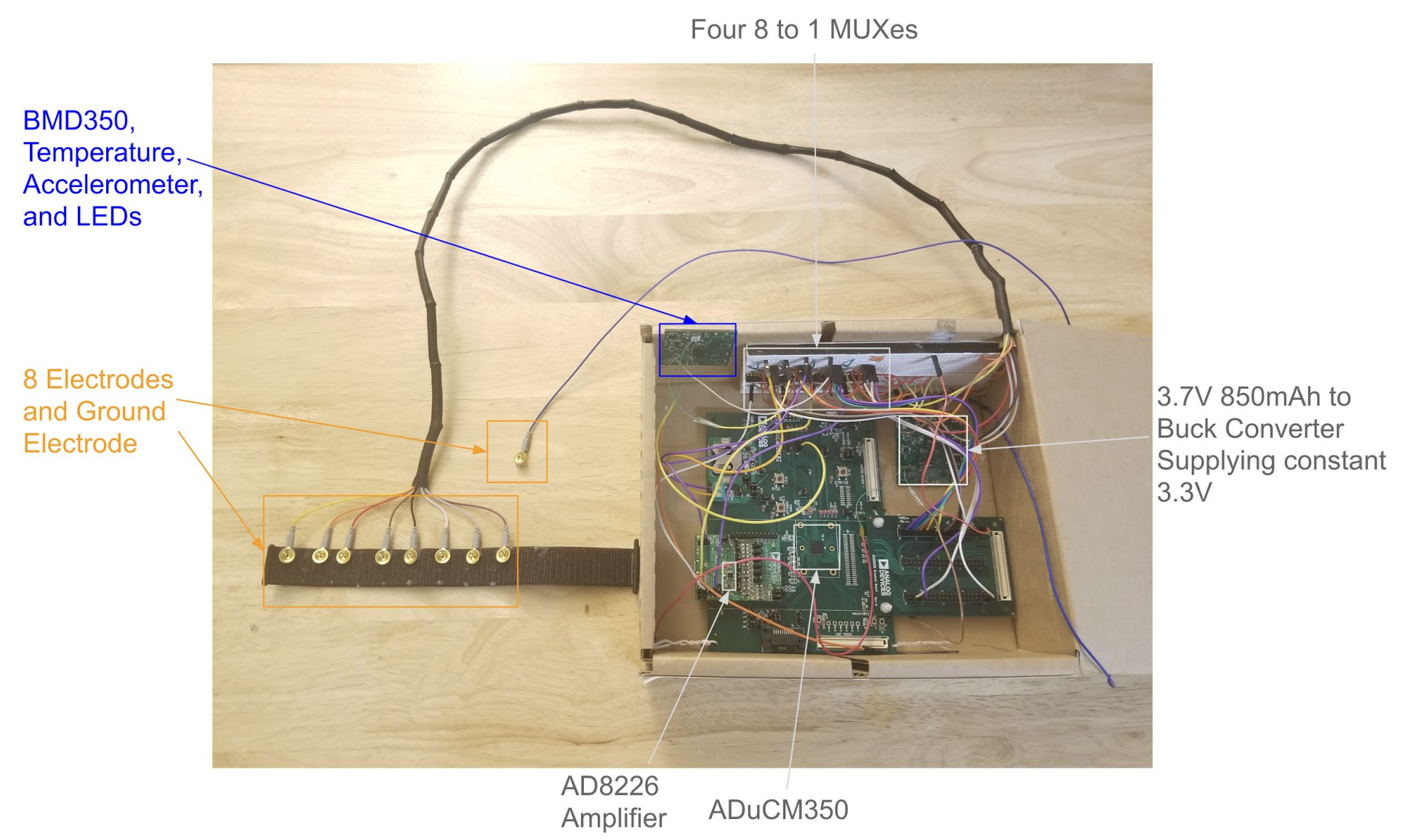
With that said, our group aims to make a low-cost wearable eczema tracking sensor specialized in the pediatric population that helps dermatologists treat their patients using the scratch monitor. It is equipped with bioimpedance tomography, accelerometer and temperature sensors for high detection accuracy. Patients will wear the sensor on the wrist of either arm with the best comfort in a specific time of interest such as during sleep, where scratching events are detected directly through the inference model in host PC and logged. An indication is given in green, yellow or red LED embedded in the device, depending on the severity of scratching through number and duration of scratches per timeframe so that guardians can notice right away. Users will also be able to log their daily information such as consumed foods, location, and skincare appliances so when superimposing the scratch severity graph with these information, dermatologists can easily find a pattern and track down which substance or environmental factor was the “trigger”.

DATA FLOWCHART



RESULTS

Device Overview



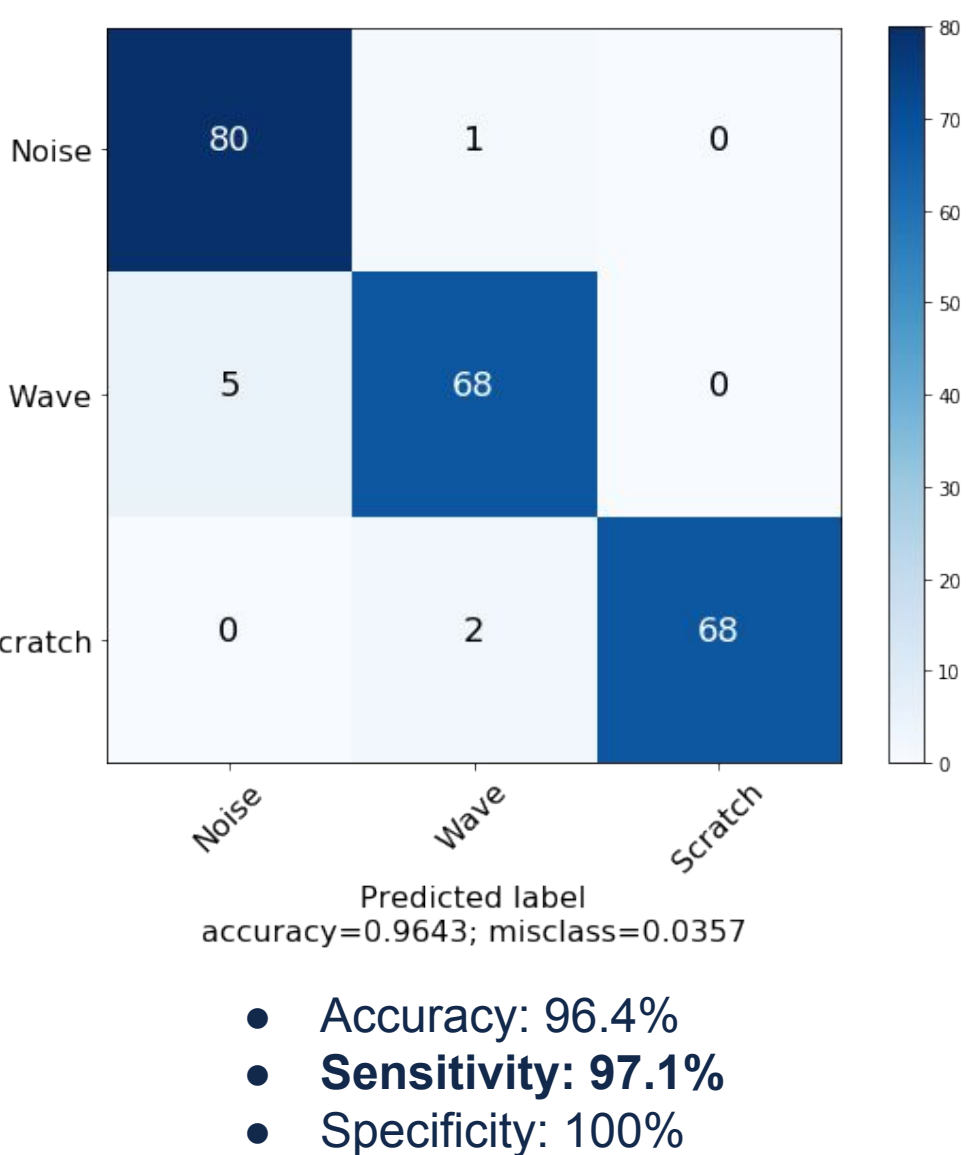
Interactive Tracking Dashboard



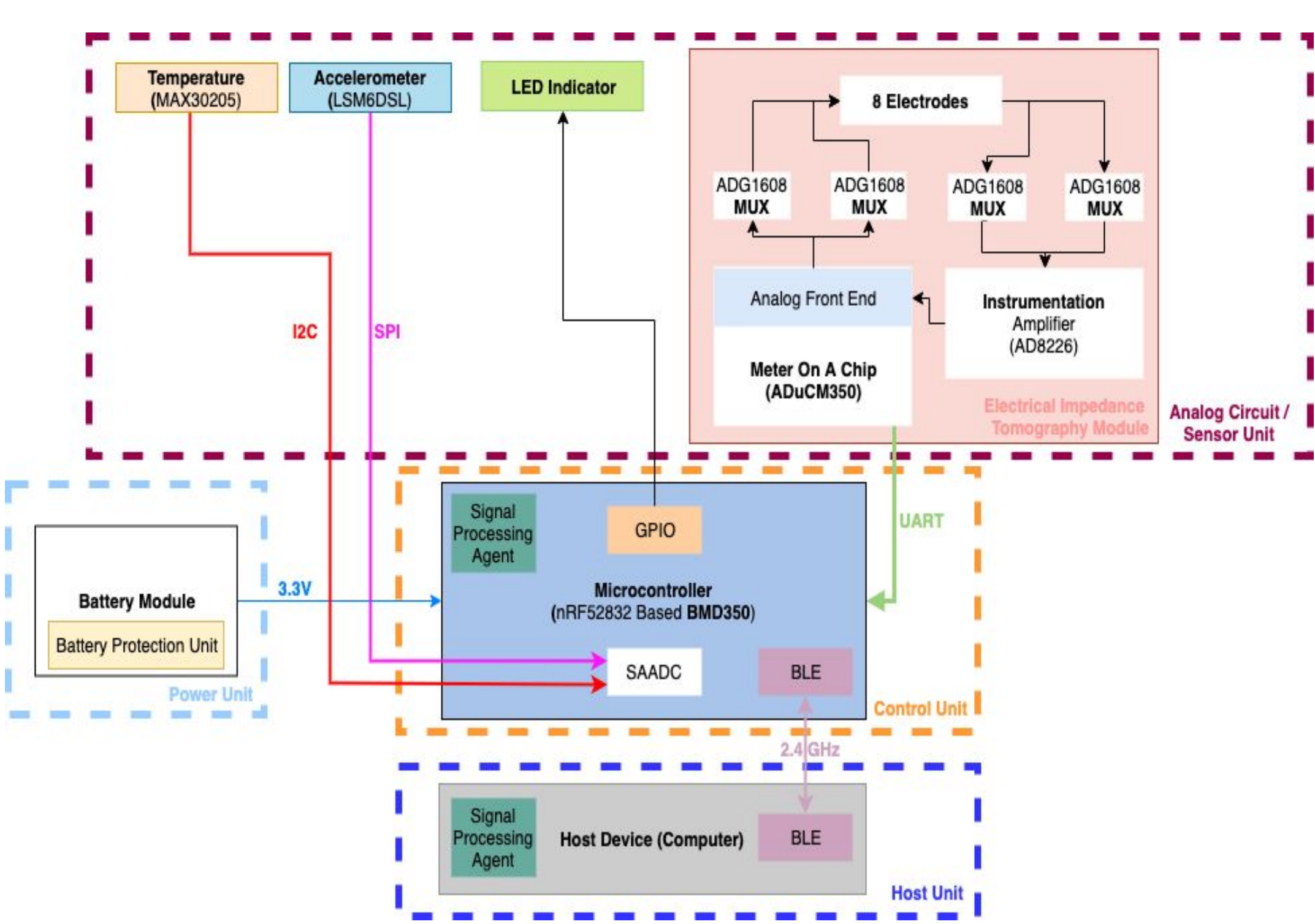
40 Ch Real-Time Plot



Classifier Performance



TOP LEVEL BLOCK DIAGRAM

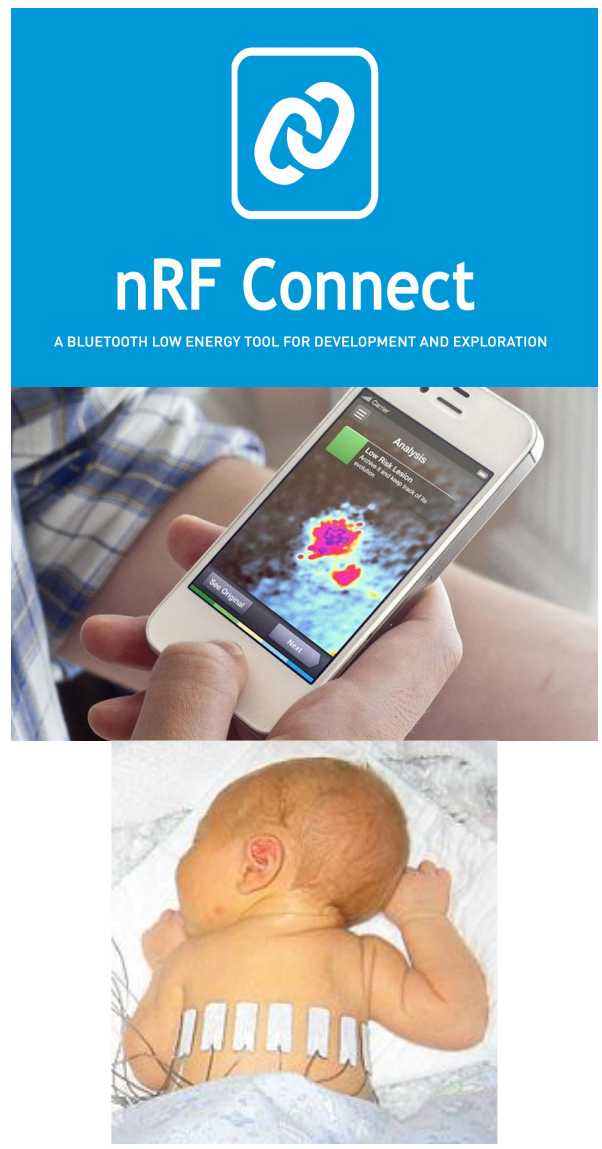


- **Power Unit** : Supplies constant 3.3V into system by buck converter
- **Temperature** : Supplies ambient temperature through I2C protocol
- **Accelerometer** : Supplies acceleration data through SPI protocol
- **BMD350** : Manages bluetooth connection and sensors’ data
- **ADuCM350** : Generates electrical impedance and tomographic data
- **LED Indicator**: Green - Not scratching, Yellow - Mildly scratching, Red - Severely Scratching
- **Host Device** : Python Dash for dermatologists to analyze data easily

CONCLUSIONS

We have successfully developed end-to-end solution for pediatric population with eczema through sensor-fused wireless device capable of streaming data for full day. With high accuracy impedance measurement of 40 channels and convolutional neural network classifier, our eczema tracker can determine if the user is scratching or not in real time with great accuracy. Combined with an interactive dashboard, dermatologists and parents can monitor the user’s severity of eczema.

FUTURE WORK



- Utilize nRF Connect Platform for mobile connection/application
- Enhance machine learning model to detect scratched **location**
- Use smartphone camera to detect **inflammation/infection** for scratched area
- Strap around chest to monitor Respiratory Distress Syndrome (RDS)