Minimizing Wireless Transmissions of Wearable Bioelectronics Using Artificial Neural Networks

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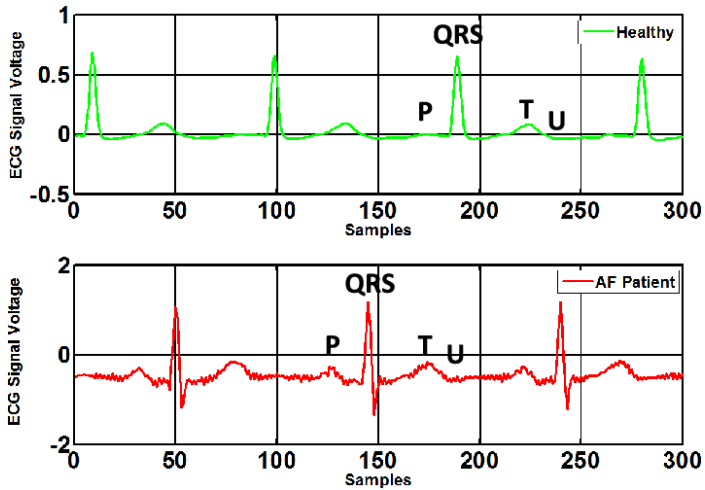
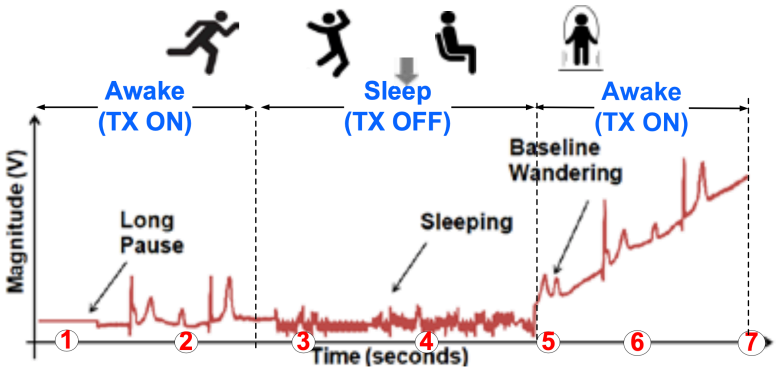
Problem

- To minimize the number of wireless transmissions our wearable bioelectronics send to the cloud on a regular basis
  - Analyze ECG waveform



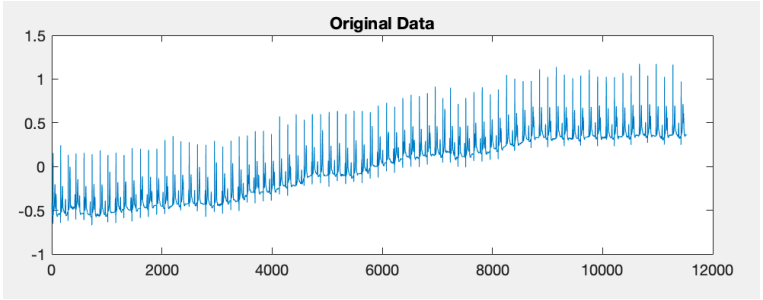


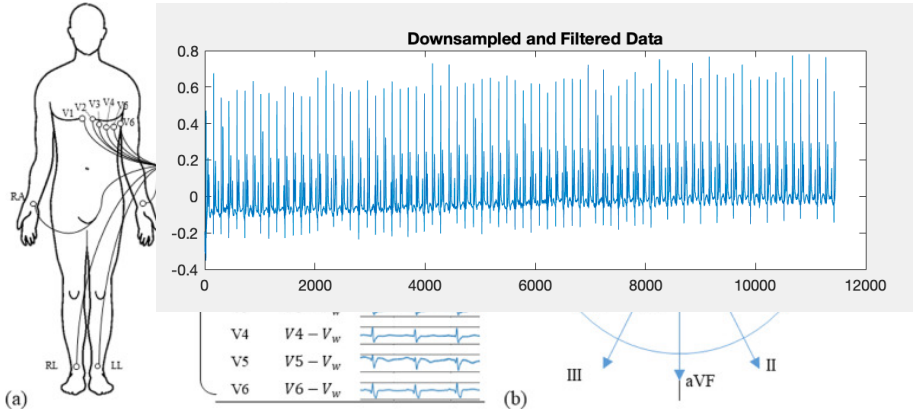
This is important because …

- Wireless transmissions consume the most energy
- Patients' health can be analyzed accurately and longer
- Research can be applied generally

Background

- Used MIT-BIH Database
  - 12-lead ECG data
- Considered only 1 of the 12 leads
- Downsampled data
- Used Low Pass Filter

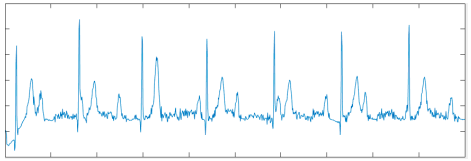




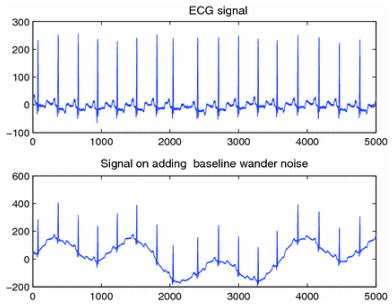
The data was corrupted.

- Corrupted data randomly in 6 ways

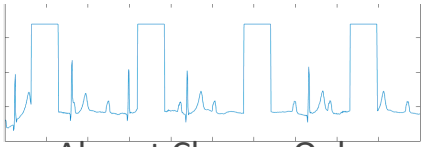
Muscle Artifacts



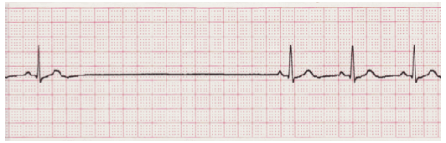
White Noise



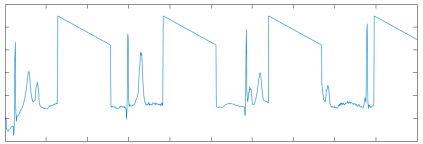
Baseline Wandering



Abrupt Change Only

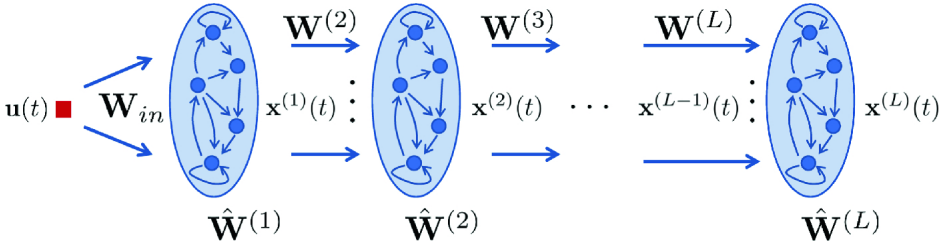


Long Pause

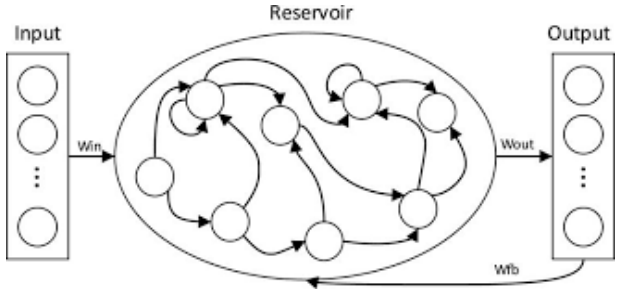


Abrupt Change and Saturation

Our approach used Deep Echo State Networks.



Deep Echo State Network

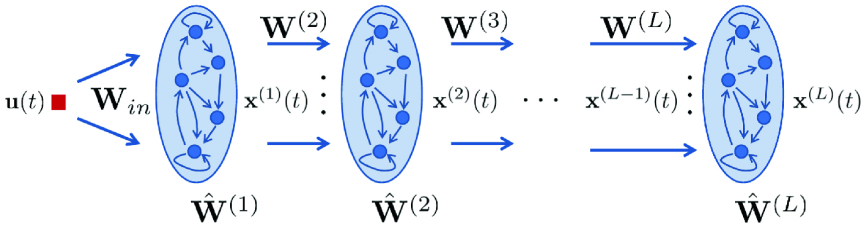


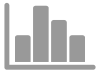
Echo State Network

- Deep Echo State Network (Deep ESN)
  - A type of Recurrent Neural Network (RNN)
  - Works well with time dependent data

We validated the approach by …

- K-fold Cross Validation
  - Number of layers of ESNs
  - Number of units in each ESN
- Average Mean Squared Error (MSE)
- Average Standard Deviation (SD)
- MATLAB Toolbox to compare to other models





1.1612% MSE

0.000686 SD

When predicting if a waveform had a specific corruption

8.0485% MSE

0.008143 SD

When predicting which of 6 corruptions the waveform had

Conclusion and Contributions

- Able to detect multiple artifacts
- Analyzed low complexity ESN vs. high complexity Deep ESN
- In the future…
  - Analyze design complexity
  - Tune more hyperparameters
  - Work with multiple leads

Thank You!

Any questions?

Feel free to reach out to me at

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