Plethysmograph for Human Biometric Recognition

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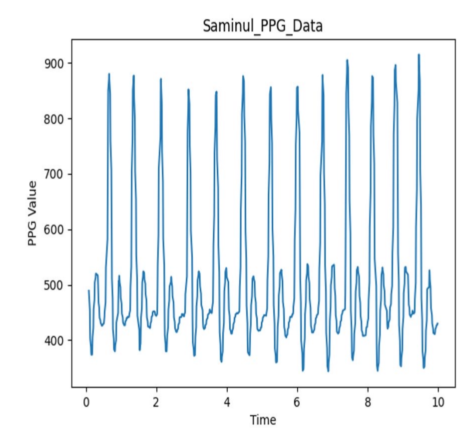
Definitions

- **PPG** : Photo Plethysmography
- **CPG** : Capacitive Plethysmography
- **SNR**: Signal-to-noise ratio
- **EER**: Equal Error rate

Background and Motivation

- Growing importance of privacy in today's digitally dominated world.
- Stronger authentication methods to ensure security.
- Biometric authentication methods cannot be forgotten or stolen.
- Research is being conducted on Plethysmogram signals as it reflects the unique features of one's blood pressure.

Plethysmography is the measure of changes in volume in different parts of body. It is especially effective in detecting changes caused by blood flow.



Every person has a unique heart signature which is reflected in their blood flow. Thus we can use plethysmography to measure that unique signal and use it for authentication.

Goals

- The goal of this project is to develop a method for using plethysmography signals measured from the human touch to provide biometric recognition and authentication
- Improve accuracy of existing Machine Learning Models that can classify signals measured using a PPG Device
- End to End Flow for training a PPG Model for a user and authenticating user

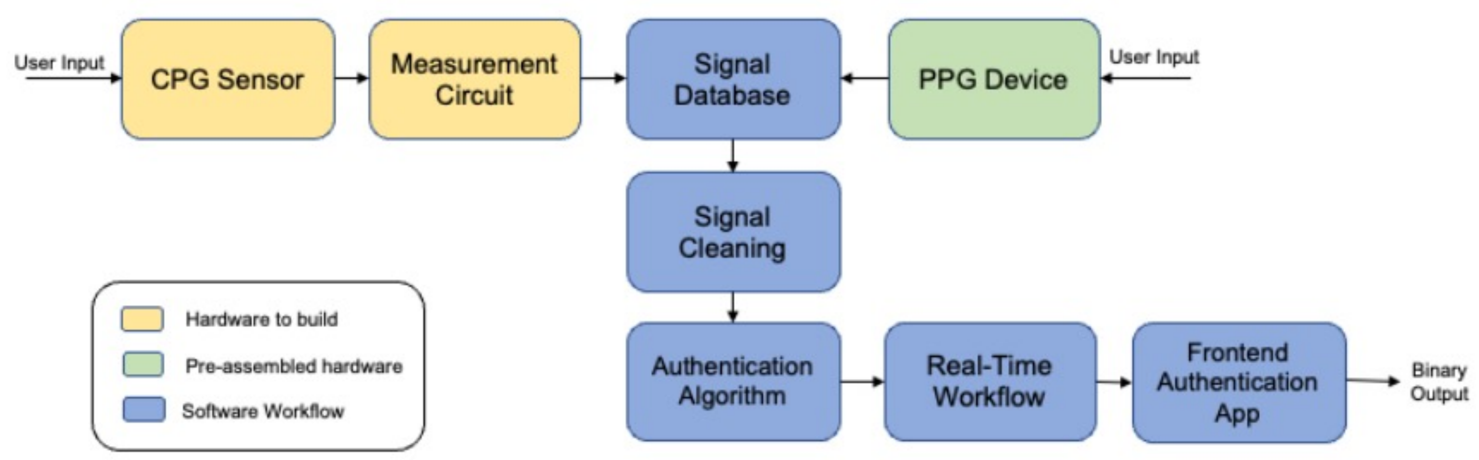
Requirements

1. Sampling Frequency > 200Hz
2. Data Storage > 1 MB
3. SNR > 10db
4. EER < 25%
5. Real Time Training on User
6. Binary Output to Authenticate User

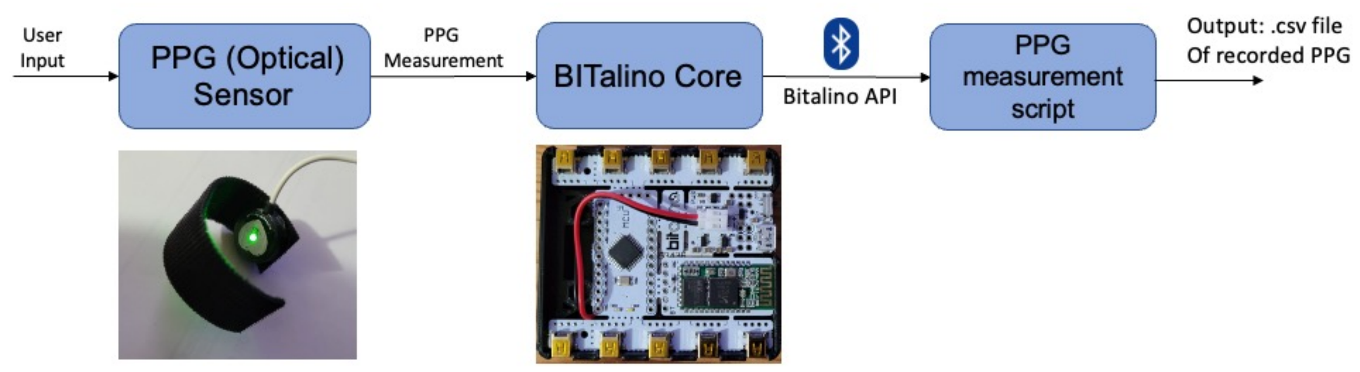
Final Design Overview

Below is an breakdown of the major components of our final design.

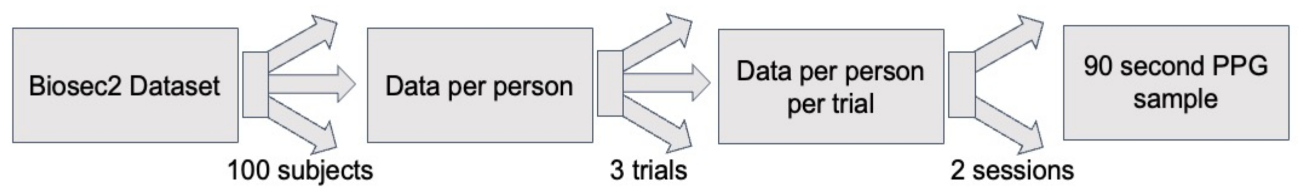
System-Level Overview



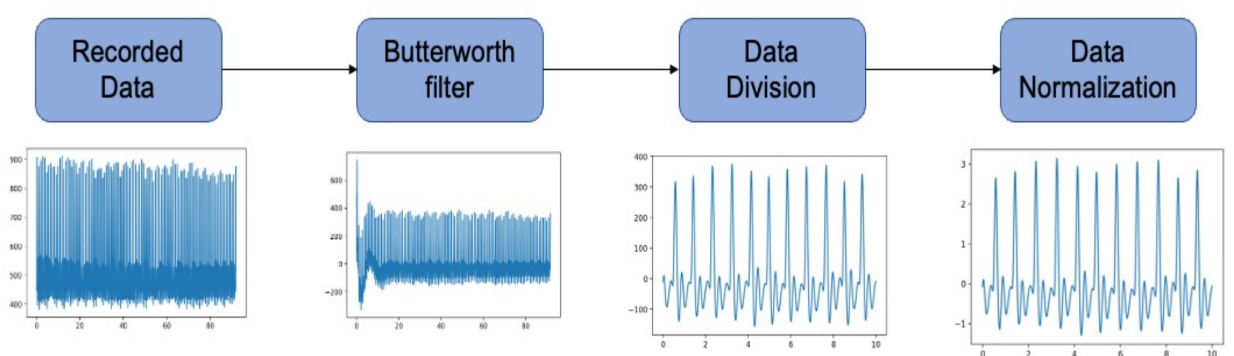
PPG Device Flow



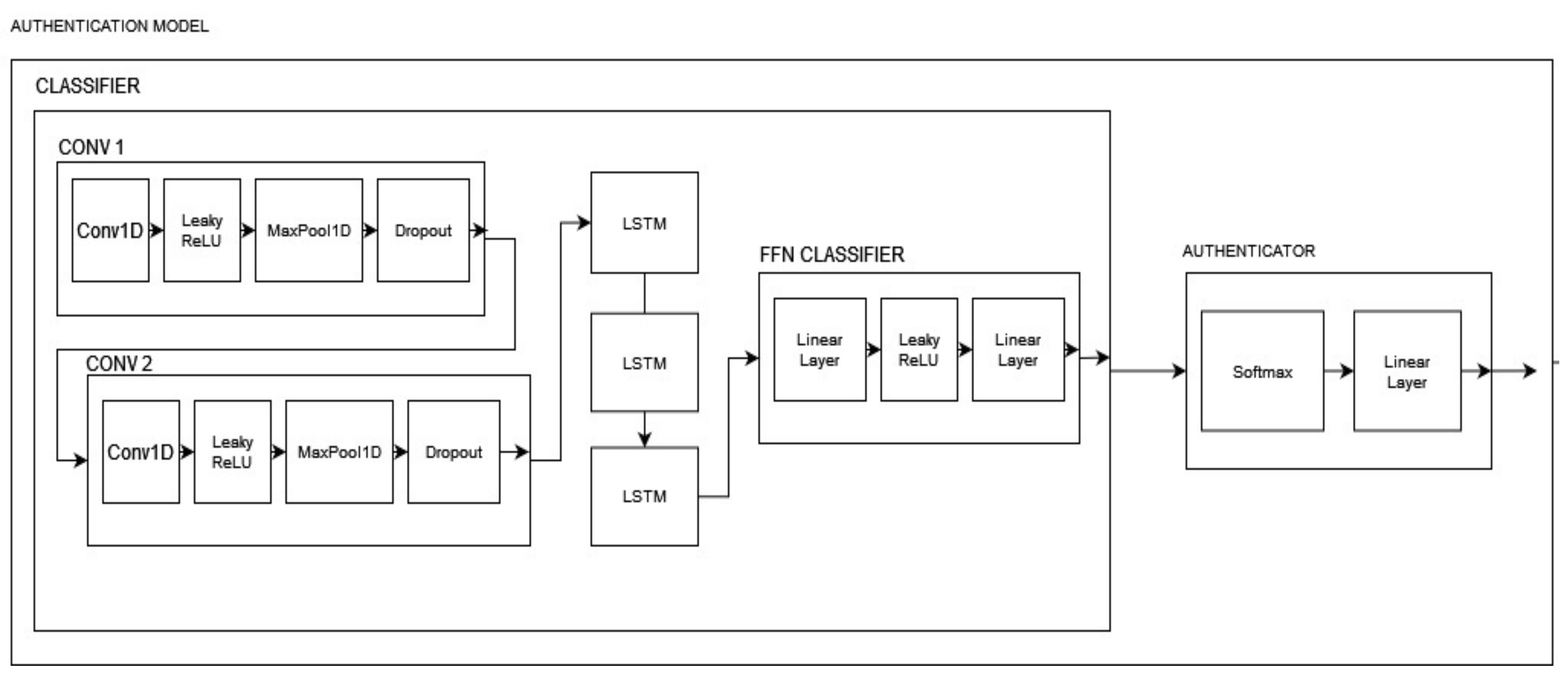
PPG Database



Data cleaning



Authentication Algorithm



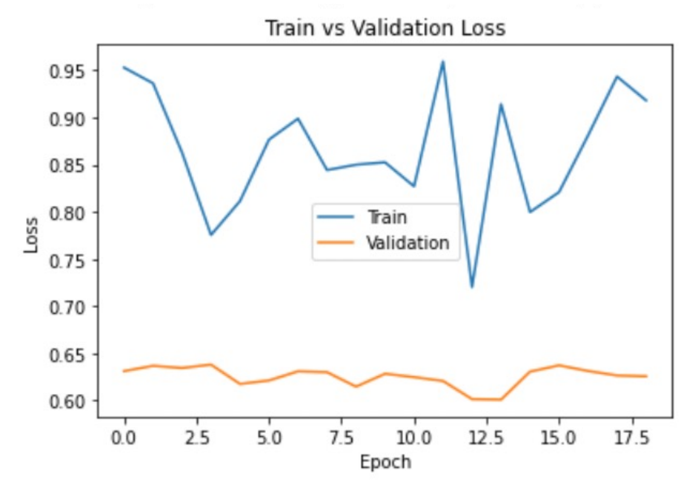
Design Challenges

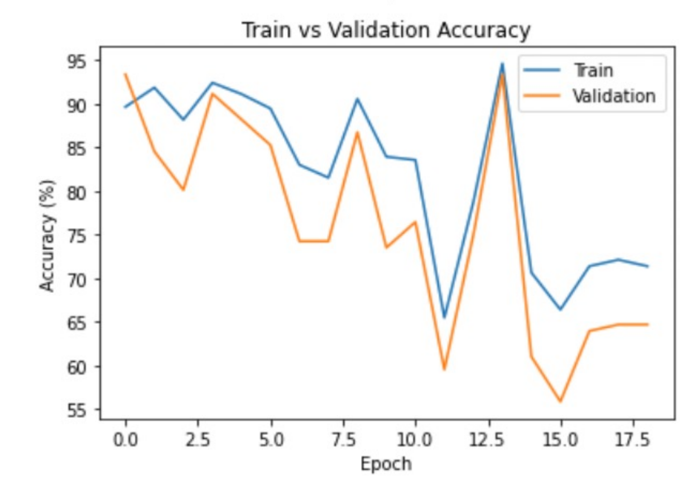
The initial aim of this project was to build a capacitive sensor and use it to measure plethysmographs for use in authentication. But unfortunately, the team was unable to build a sensor that met the project requirements needed to be used for authentication. Thus, the team had to compromise and use a different type of sensor - an optical sensor for measuring the PPG signal. This was still gathering the same information, but in a different manner. Thus, many of our project requirements stayed the same, but now focusing more on the authentication models and creating a real time application where the work can be demonstrated.

Results and Conclusion

Using the PPG sensor, we were able to create a workflow that met almost all of the project requirements we set out. Our end-to-end system allows us to test and demonstrate our work to any new individual and showcase the use cases of this project. The end-to-end real-time authentication system is a development above current literature in this field, as it works as a proof-of-concept that PPG signals can be used for biometric authentication in real-world scenarios.

An EER of 25% or below was required to verify this requirement, as other PPG authentication algorithms are able to achieve such results. As such, the design fails this requirement. However, this is forgivable, as adding real-time functionality for any individual reduces this model's performance as compared to authentication systems that are trained on a single specific participant in a provided dataset.



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Best Validation Accuracy is  93.38235294117648
Average test accuracy: 79.33044733044733
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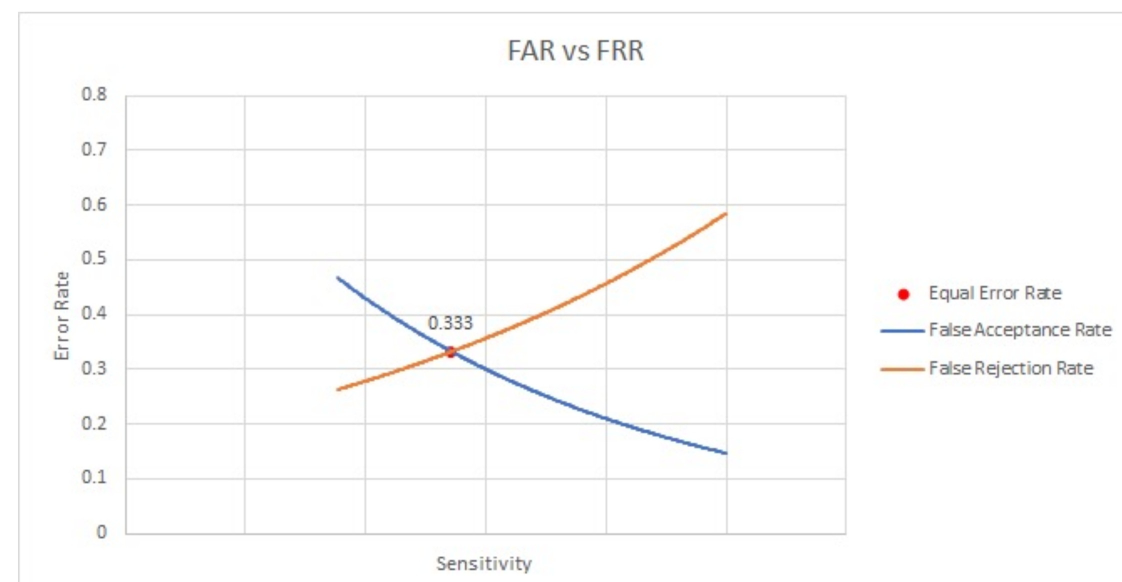

Final EER 33.3%