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# Nonlinear Data Analytics Project Proposal

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## 1 Project Overview

### 1.1 Description

#### Project Type (1)

1. Application of existing algorithm to a new problem and potentially new data.

### 1.2 Requirements

- **Partner:** Work independently.
- **Dataset:** HMOG cell phone data from at least five users/activities. Will apply data analytics and ML methods using accelerometer, gyroscope and magnetometer data (3-axis each).
- **Format:**  $\text{\LaTeX}$  NIPS
- **Code Style:** Will use suggested code style guidelines (cookiecutter data science) with MIT open-source license.
- **Programming Tools & Hardware:** Python/Jupyter Notebook, C++, NVIDIA Jetson Nano with Jetpack API.

### 1.3 Proposed Project

I would like to use the probabilistic models and data analytics methods introduced in the paper [1] *Using Inertial Sensors for Position and Orientation Estimation* to estimate the position and orientation (pose) of a users cell phone during an activity. Cell phone 3D accelerometer, gyroscope and magnetometer data will be obtained for analysis from the HMOG dataset associated with the article [2] *HMOG: New Behavioral Biometric Features for Continuous Authentication of Smartphone Users*.

**Here are the proposed techniques for data analytics discussed in [1] *Using Inertial Sensors for Pose Estimation*:**

- **(Ch2) Inertial Sensors:** Coordinate frames, angular velocity, specific force, sensor error.
- **(Ch3) Probabilistic Models:** Parameterizing/probabilistic orientation modeling (Euler angles, Unit quaternions), measurement/probabilistic models for pose estimation.
- **(Ch4) Estimating Position and Orientation:** Smoothing in optimized frame (Gauss-Newton estimation, uncertainty), smoothing estimation of orientation using optimization, filtering estimate of orientation using optimization, filtering estimate in optimization framework, extended Kalman filtering / complementary filtering.

## References

[1] Manon Kok, Jeroen D. Hol and Thomas B. Schon (2017), Using Inertial Sensors for Position and Orientation Estimation, *Foundations and Trends in Signal Processing: Vol. 11: No. 1-2*, pp 1-153.  
<http://dx.doi.org/10.1561/20000000094>

[2] SITOVÁ, Zdeňka, Jaroslav ŠEDĚNKA, Qing YANG, Ge PENG, Gang ZHOU, Paolo GASTI and Kiran BALAGANI. HMOG: New Behavioral Biometric Features for Continuous Authentication of Smartphone Users. *IEEE Transactions on Information Forensics and Security*, 2016, Vol. 11, No. 5, p. 877 - 892. ISSN 1556-6013. <http://dx.doi.org/10.1109/TIFS.2015.2506542>