Indoor Localization Using Inertial Navigation

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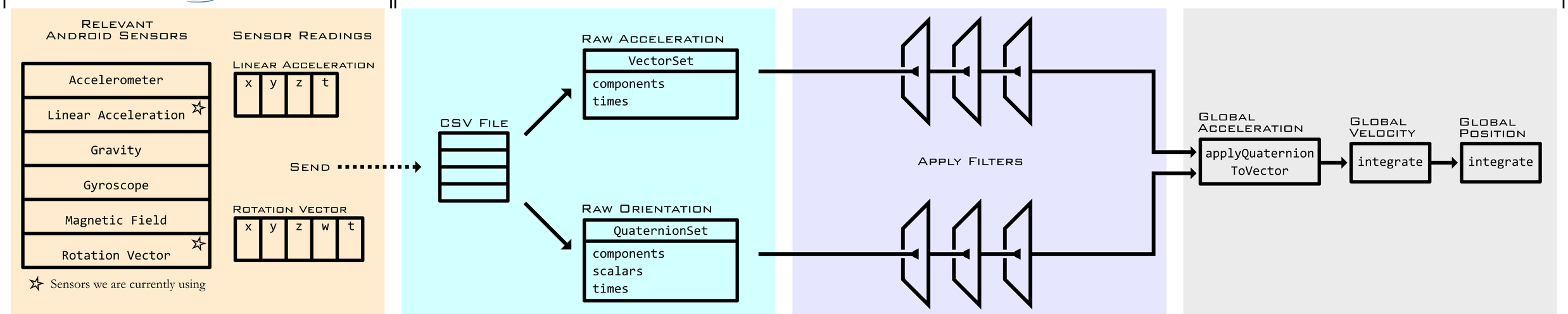


Sensing

Linear Acceleration:
Measures the acceleration force in m/s^2 that is applied to a device on all three physical axes (x, y, and z), *excluding the force of gravity.*

Rotation Vector:
Measures the orientation of a device by providing in *quaternion* form (x, y, z, and w).

Organizing

Data is sliced from the CSV file and stored in data structures, *VectorSet and QuaternionSet.*

Reusability:
These custom data structures inherit from NumPy's "ndarray". This allows them to be seamlessly used with algorithms from packages including NumPy, SciPy, etc.

Filtering

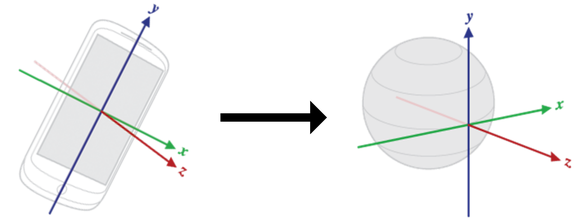
Moving Average:
Splits data into segments, then averages data within each segment. Helps synchronize data.

Low-Pass:
Helps smooth spikes and noise

High-Pass:
Helps reduce low frequency effects, e.g, gravity

Fusing

Global Acceleration:
Orientation must be applied to the local acceleration (along the phone's axes) to obtain global acceleration (along the world's axes)



Global Position:
Position is calculated by integrating acceleration twice.

Cumulative trapezoids is the method of integration being used.

Sending

Android app sends the sensor data as a CSV file, via email.

Room for Improvement (future):
Data will be sent real-time with Bluetooth.

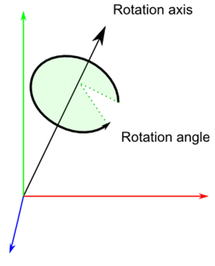
OpenGL can then be used for visualizing real-time position of the phone.

How Orientation Works

Axis-Angle Representation:
Visually intuitive, algebraically not

4D representation of a 3D rotation.
Contain a vector and a scalar.

Cannot apply the rotation to a vector.
Must convert to quaternion.



Quaternions:
Algebraically intuitive, visually not

4D representation of a 3D rotation.
Contain a vector and a scalar.

Easily interpolated
Easy to apply to a vector

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