# **Scalar Factor and Bias Estimation Together Using EKF**

# **1. State Vector:**

: bias of acceleration along axes

: scalar multiplied by skew matrix factors

# **2. Measurement Vector:**

: accelerations along body axes of cellphone

# **3. Based on the error model:**

# **3. State Function:**

Model:

Predict:

Update:

: prediction error matrix

: covariance matrix of how quickly acc/state changes:

: covariance matrix of

where

# **Results:**

* **Initialization matters**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |  |  |  |
| ground | **0.98** | **0.0198** | **0.0291** | **0.9920** | **-0.0097** | **0.9700** | **0.01** | **-0.02** | **0.01** |
| Initial1 | 0.9868 | 0.0168 | 0.0296 | 0.9930 | -0.0110 | 0.9702 | 0.0068 | -0.0139 | 0.0078 |
| Initial2 | 0.9866 | 0.0164 | 0.0287 | 0.9934 | -0.0096 | 0.9701 | 0.0118 | -0.0205 | 0.0095 |

Therefore, use previous calibration results as initial values in online estimation.

* **Noise Level matters**

*Standard deviation > 0.001 affect accuracy, need pre-filtering before bias and scalar estimation*

**Increase Orientations to 12 orientations**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |  |  |  |
|  | **0.98** | **0.0198** | **0.0291** | **0.9920** | **-0.0097** | **0.9700** | **0.01** | **-0.02** | **0.01** |
| 6 orient | 0.9580 | -0.0864 | 0.0922 | 0.6202 | 0.6299 | 0.7179 | 0.2163 | 0.0455 | 0.0146 |
| 12 orient | 0.9837 | 0.0188 | 0.0306 | 0.9898 | 0.0421 | 0.9089 | 0.0025 | -0.0420 | 0.0066 |
| 18 orient | 0.9827 | 0.0190 | 0.0296 | 0.9919 | 0.0018 | 0.9557 | 0.0080 | -0.0240 | 0.0097 |
| 24 orient | 0.9818 | 0.0191 | 0.0293 | 0.9920 | -0.0038 | 0.9626 | 0.0093 | -0.0221 | 0.0100 |

* **More orientations better results**

**Chart, line chart

Description automatically generated**