Motion based calibration between IMU and camera

Tests on real data

Number of sensor readings : N
Estimated rotation matrix : R
Estimated euler angles : (z y x) in radians

Case I
- Expected rotation estimate : (0 0 0) ie the sensor frames are aligned
- Motion about all the three axes is caused

For N = 50,

```
R = 0.8648   -0.4052   -0.2964
    0.3077    0.8943   -0.3249
    0.3967    0.1897    0.8981

(z y x) = (0.3418   -0.4080    0.2082)
```

For N = 100,

```
R = 0.9778   -0.1793   -0.1084
    0.1372    0.9391   -0.1084
    0.1583    0.2932    0.9428

(z y x) = (0.1394   -0.1590    0.3015)
```

For N = 500,

```
R = 0.9981    0.0123    0.0609
   -0.0083    0.9978   -0.0658
   -0.0615    0.0651    0.9960
```

(z y x) = (-0.0083   0.0616   0.0653)

Case II
- Expected rotation estimate : (-pi/2 0 -pi/2)
- Motion about all the three axes is caused

For N = 50,

```
R = -0.0172   -0.5117   -0.8590
```

```
    -0.9957    0.0872   -0.0320
    -0.0913   -0.8547    0.5110

(z y x) = (-1.5881    0.0914   -1.0320)
```

For N = 100,

```
R = -0.1581    0.0676    0.9851
    -0.9731   -0.1798   -0.1439
     0.1674   -0.9814    0.0942

(z y x) = (-1.7319   -0.1682   -1.4751)
```

For N = 500,

```
R = 0.0054   -0.1477    0.9890
   -0.9996   -0.0278    0.0013
    0.0273   -0.9886   -0.1478
```

(z y x) = (-1.5653   -0.0273   -1.7192)

Case III

- Expected rotation estimate : (0 0 0) ie the sensor frames are aligned
- Motion about only Y axis is caused

For N = 50,

```
R = 0.411184  0.0924048   0.906857
    -0.179197   0.983631 -0.0189769
    -0.893766  -0.154703   0.421012

(z y x) = (-0.893766  -0.154703   0.421012)
```

For N = 100,

```
R = 0.8468    0.1107    0.5203
   -0.1082    0.9935   -0.0352
   -0.5208   -0.0265    0.8533

(z y x) = -0.1271    0.5478   -0.0310
```

For N = 500,

```
R =  0.8876   -0.0137   -0.4604
    -0.0017    0.9995   -0.0331
     0.4606    0.0301    0.8871
```

(z y x) = (-0.0019 -0.4787 0.0340)

Tests on synthetic data

Case I

- Expected rotation estimate : (0 pi/4 0)
- Motion about all the three axes is caused

For N = 100,

```
R = 0.7071    0.0000    0.7071
   -0.0000    1.0000   -0.0000
   -0.7071   -0.0000    0.7071
```

```
(z y x) = (-0.0000  0.7854  -0.0000)
```

For N = 500,

```
R = 0.7071   -0.0000    0.7071
    0.0000    1.0000    0.0000
   -0.7071    0.0000    0.7071
```

(z y x) = (0.0000 0.7854 0.0000)

Case II

- Expected rotation estimate : (0 pi/4 0)
- Motion about only the Z axis is caused

For N = 100,

```
R = -0.7071  0     -0.7071
    0       -1.0   0
   -0.7071   0     0.7071
```

```
(z y x) = (3.1416  0.7854  0)
```

For N = 500,

```
R = 0        −1.0  0
    0.7071   0    0.7071
   −0.7071   0    0.7071

(z y x) = (1.5708  0.7854  0)
```

For N = 10000,

```
R = 0.7071         0    0.7071
         0    1.0000         0
    −0.7071         0    0.7071
```

(z y x) = (0 0.7854 0)

Observation

- The accuracy of the estimates seems to increase with the number of readings
- Accuracy can be further improved by causing motion about all the three axes