MEMS GYROS

Peter Harrison

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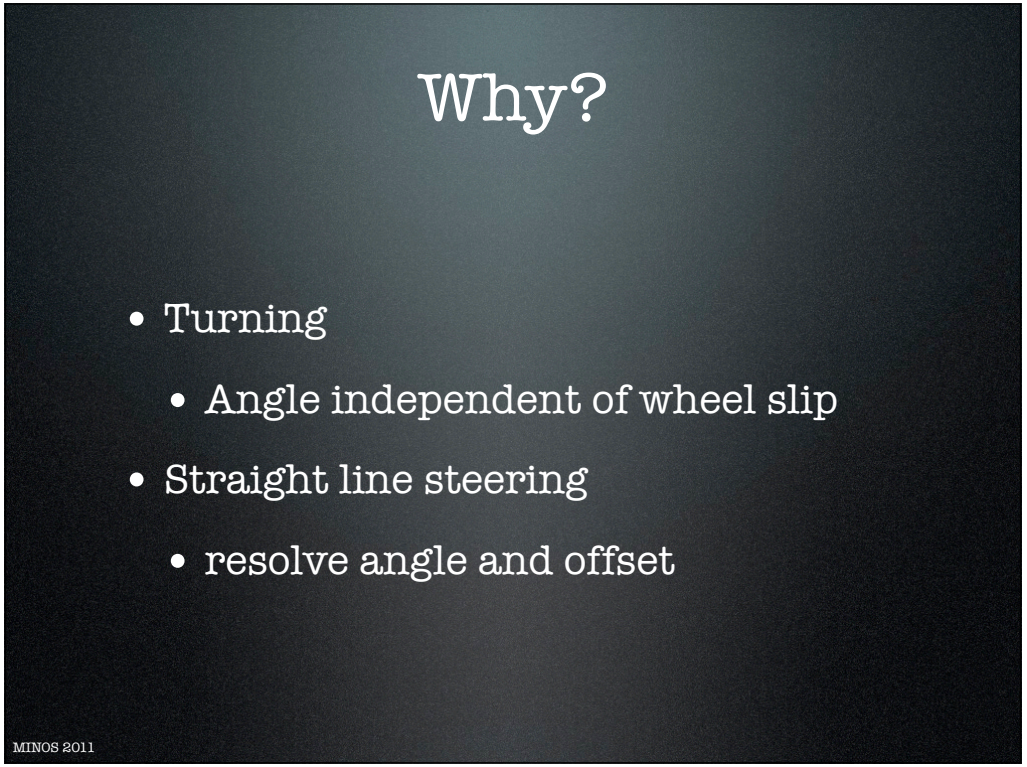
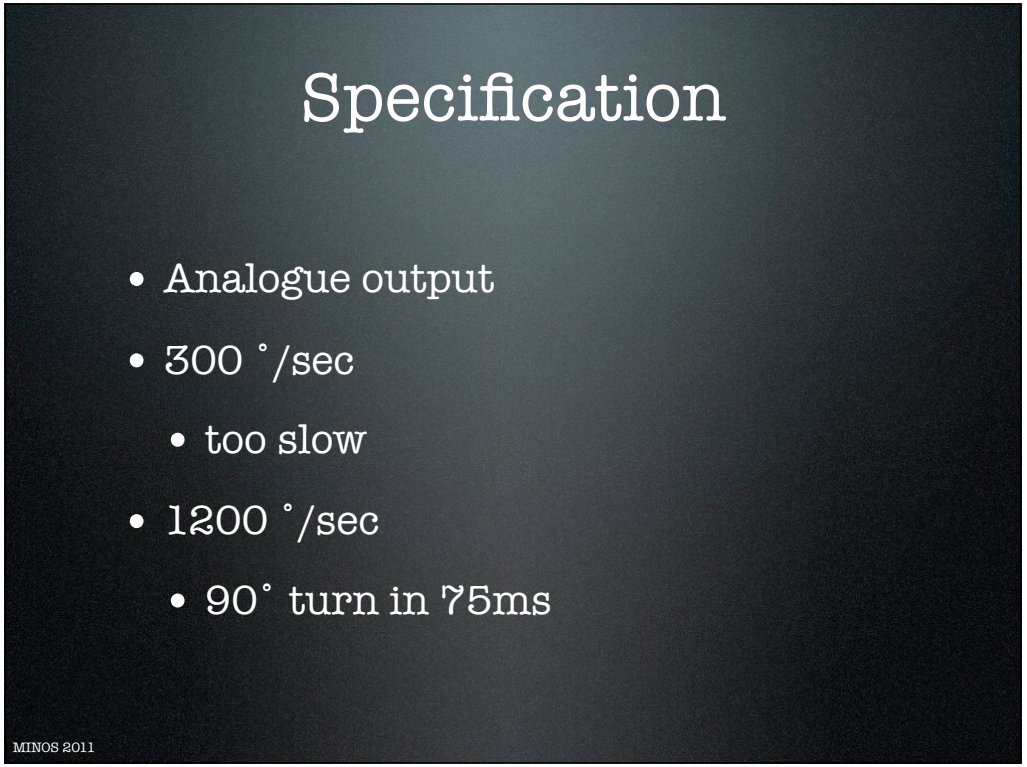


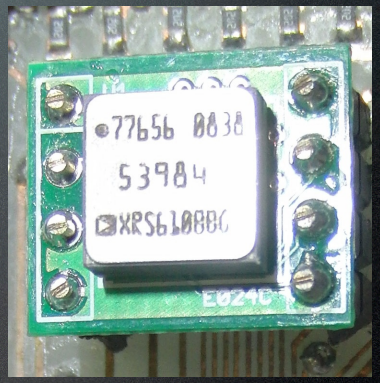
Well, why not?
Micromice seem to have stepped improvement curves.



Specification is a compromise. Few devices ready-to-use at purchase.

Analog Devices

- ADXRS610
- ±300 ˚/sec
- £40
- 5V
- BGA32



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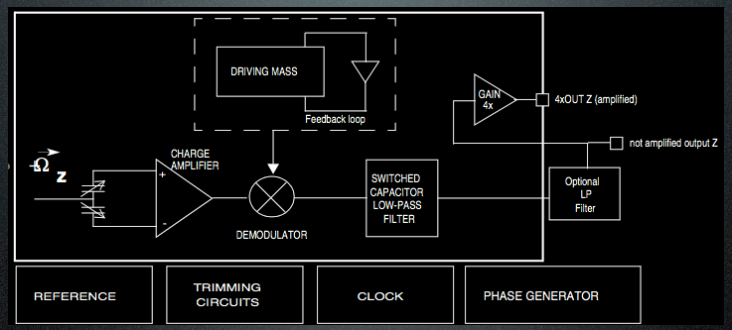
One of the earlier devices. Still common if you must.

ST Microelectronics LY530ALH



3.3V
300 ˚/sec and 1200 ˚/sec
LGA-16L (5mm x 5mm)
£5 (Future Electronics)

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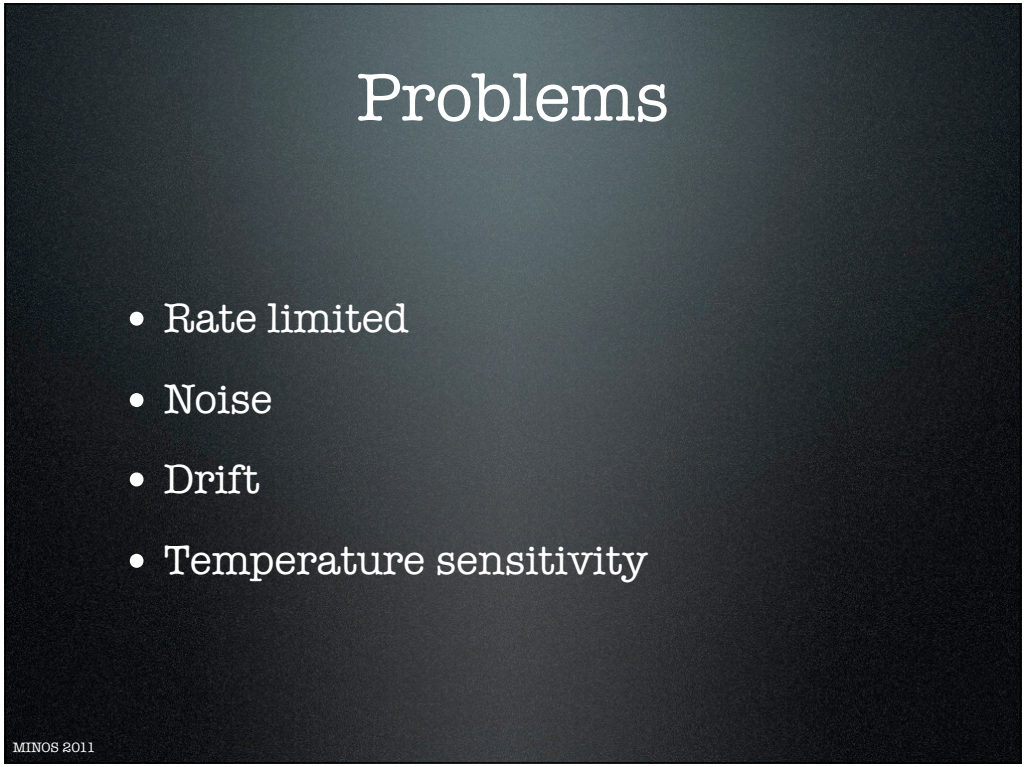
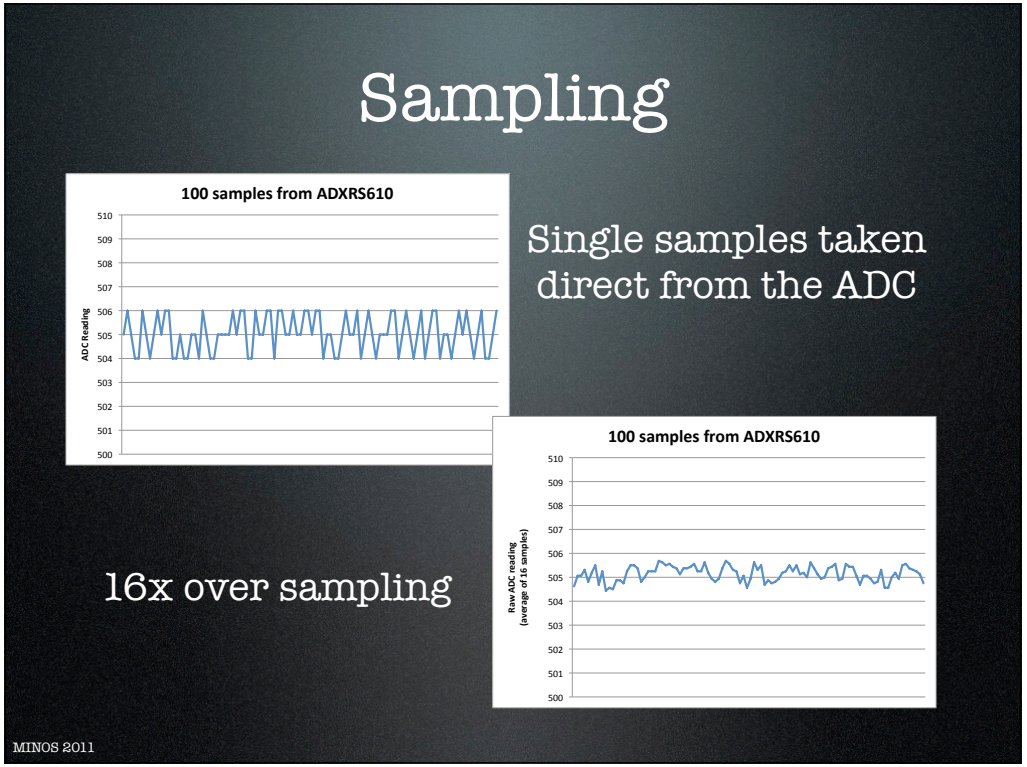
Cheap and convenient. One of several devices fromST. Or raid your Wiimote etc

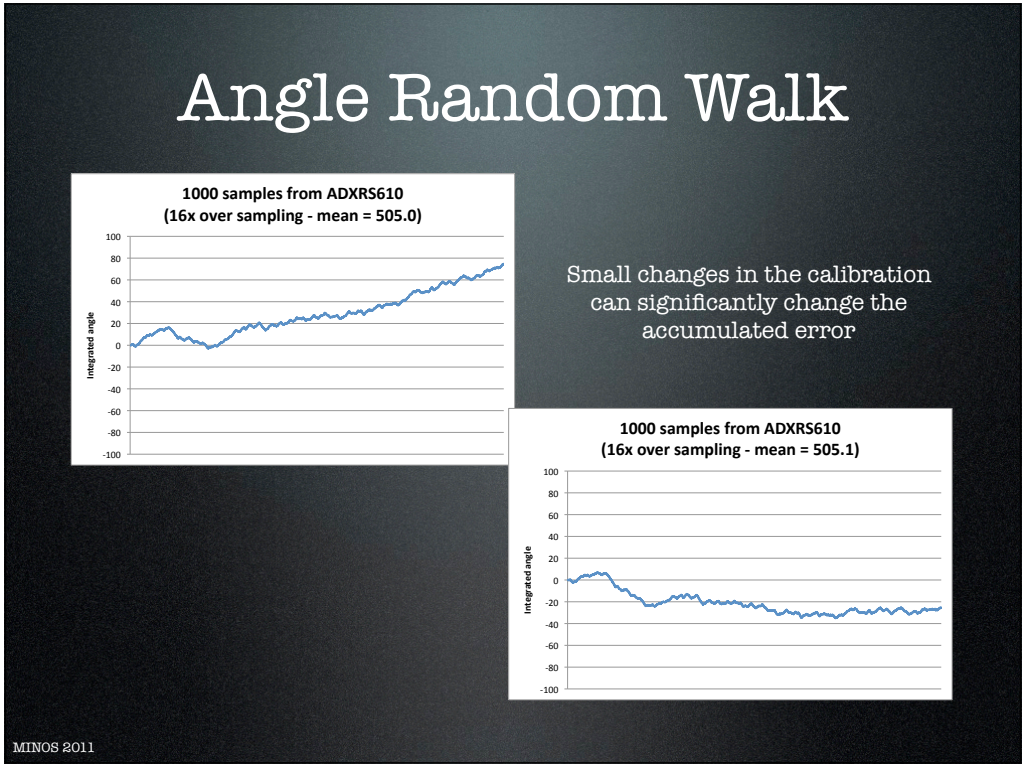


Thse are not perfect devices and need some care and thought in their use.

Drift is the most widely noticed shortcoming of gyros. It is caused by intrinsic noise.
the measurement technique has a great significance as well.

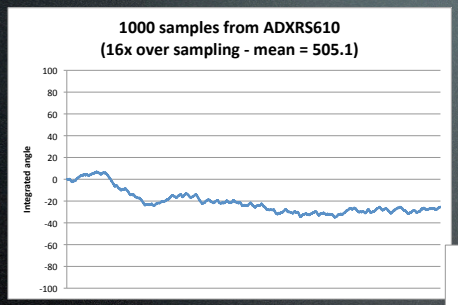


For spot measurements of angular velocity, oversampling reduces noise. Only one bit improvement for each doubling though.

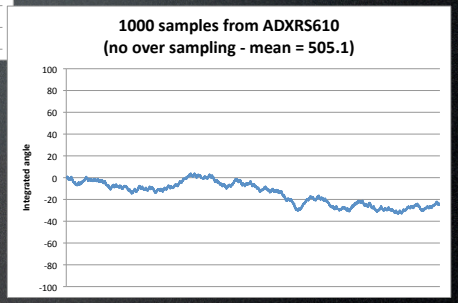


Observed angle random walk depends heavily upon the bias level used.

Angle Random Walk



Over a long period, random noise tends to cancel out and oversampling may not be needed



Or this trial could have been lucky. A controlled comparison has not been done.

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Since integration is an excellent way of removing random noise, oversampling may be unnecessary when recording angles by integration.

Allen Deviation

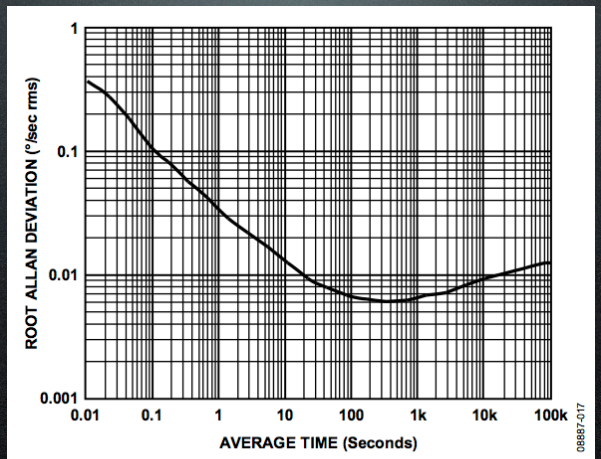

Figure 18. Typical Root Allan Deviation at 25°C vs. Averaging Time

ADXRS620 - from the Analog Devices Datasheet

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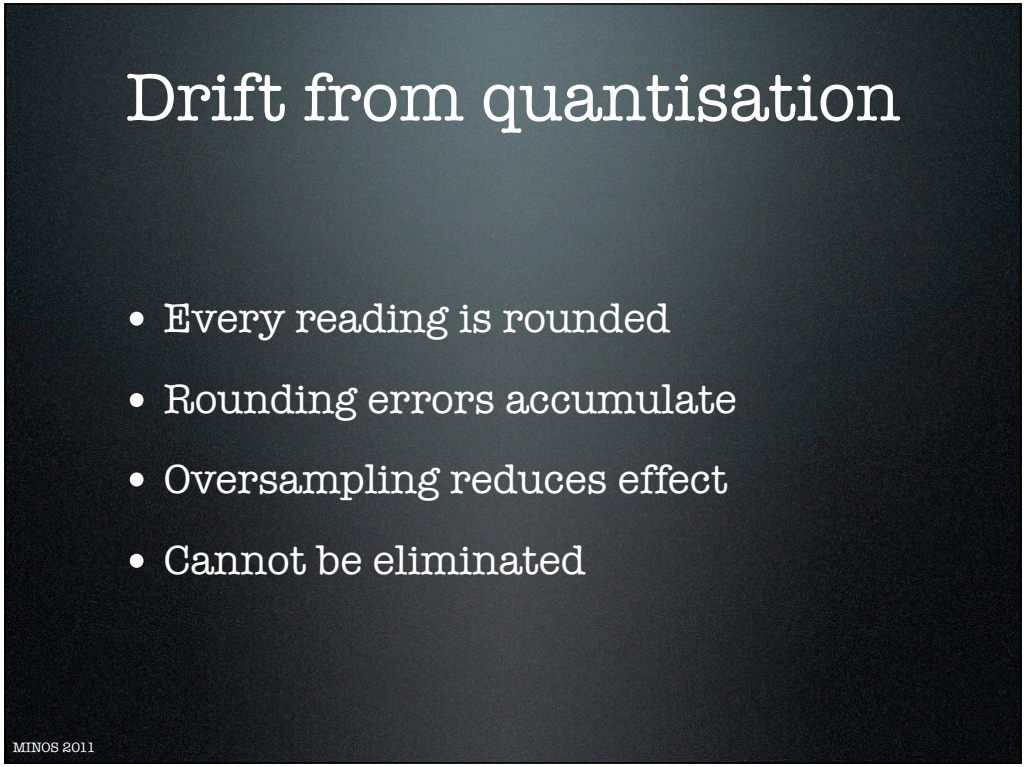
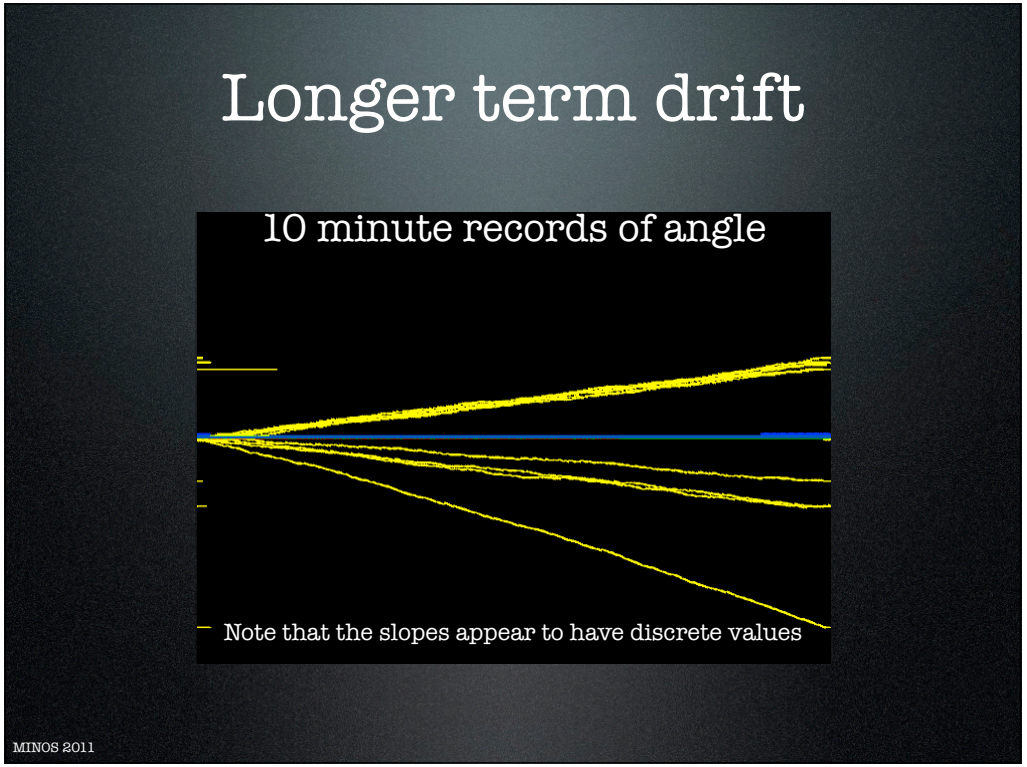
Allen Variance tells us that short term averages are less likely to be accurate than longer ones. however, beyond a point (the bias [in]stability), things can get worse. here, an average over 1 second should put 63% of averages within +/- 0.03 deg/second of the true value.



Many simple decimal fractions cannot be represented as binary fractions.
There is ALWAYS a potential problem with cumulative errors.



A combination of changes in temperature and the short term average taken at the start of each run means that the runs all show different drifts. I think that the discrete slopes indicate rounding effects in the ADC

Temperature sensitivity

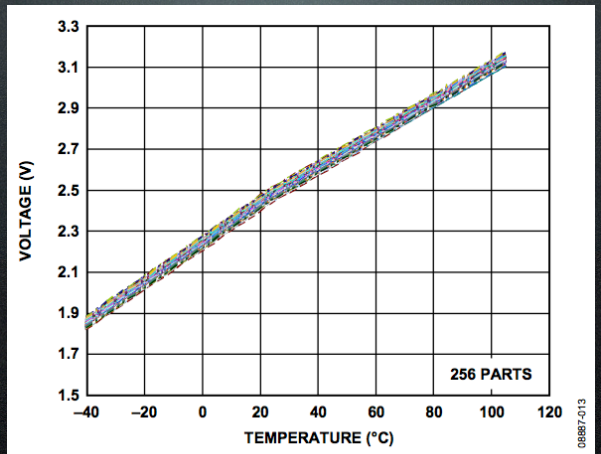
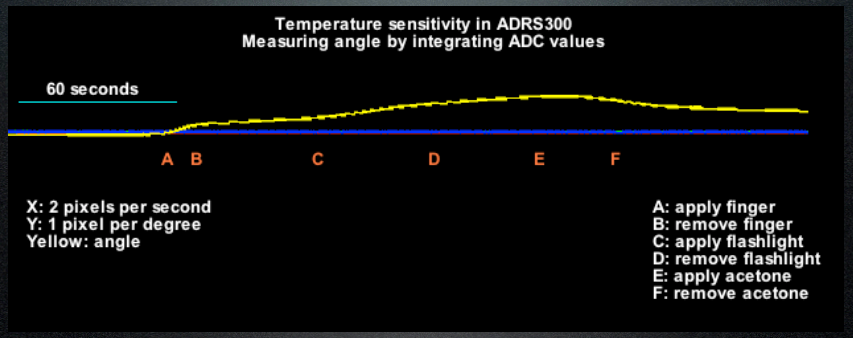


Figure 14. V_{TEMP} Output over Temperature (V_{RATIO} = 5 V)

ADXRS620 - from the Analog Devices Datasheet

Since we care about small changes in the output bias when integrating to get angles, the changes in that bias due to temperature might become a problem

Temperature Sensitivity



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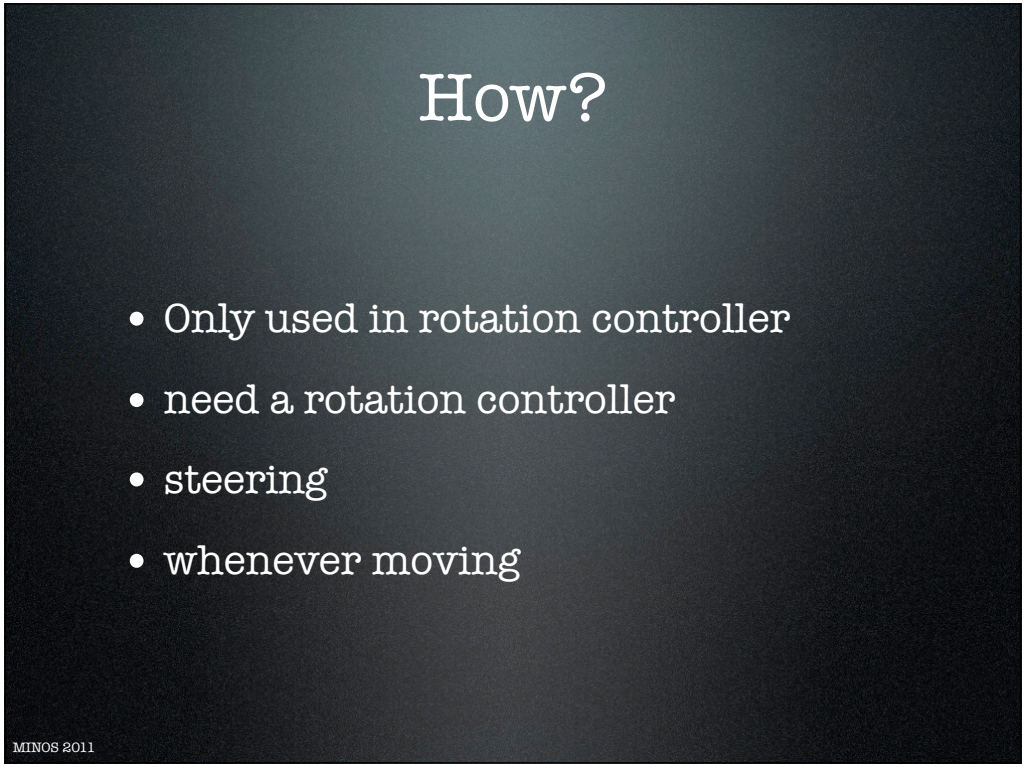
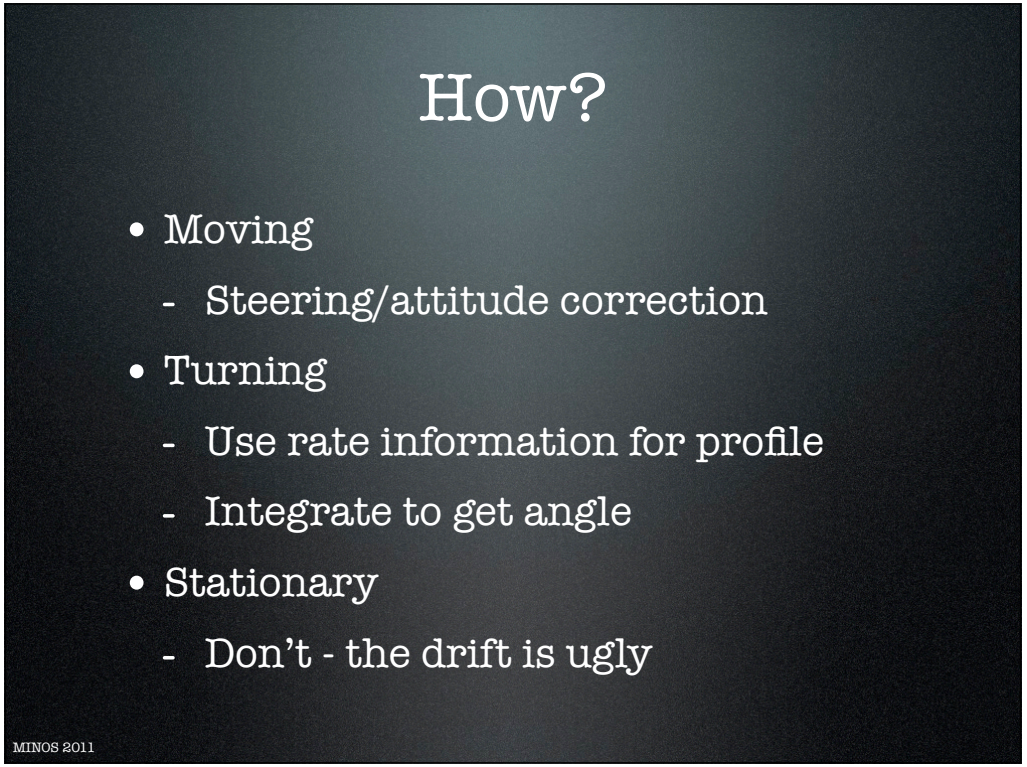
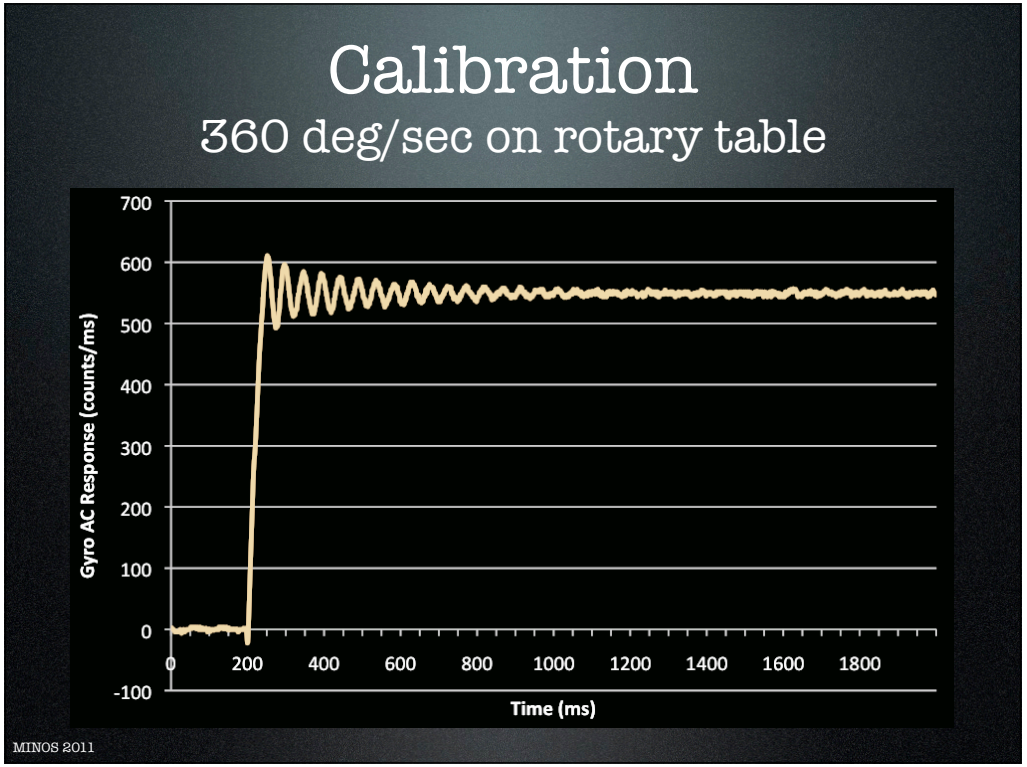
Angle is badly affected by temperature.
Effects should be small over short timescales



task is much easier with separate forward and rotation controllers



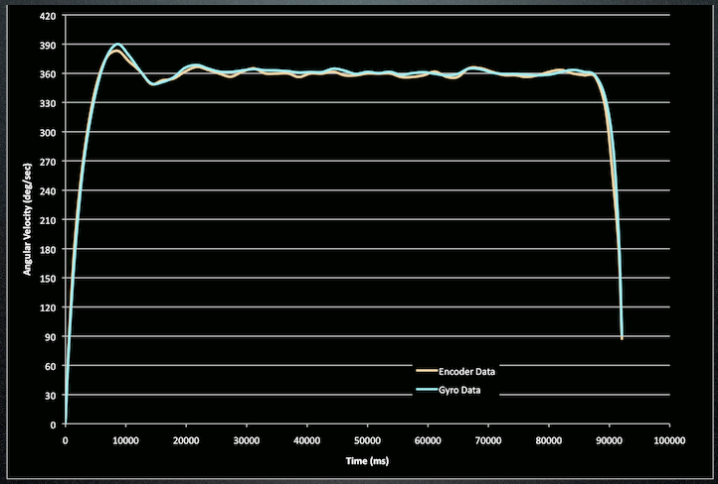
Only use the gyro when you are moving.



Sampled every millisecond. So, approximately 500000 counts per revolution.
Very high resolution.

Single turn 360 deg/sec

Encoders vs gyro



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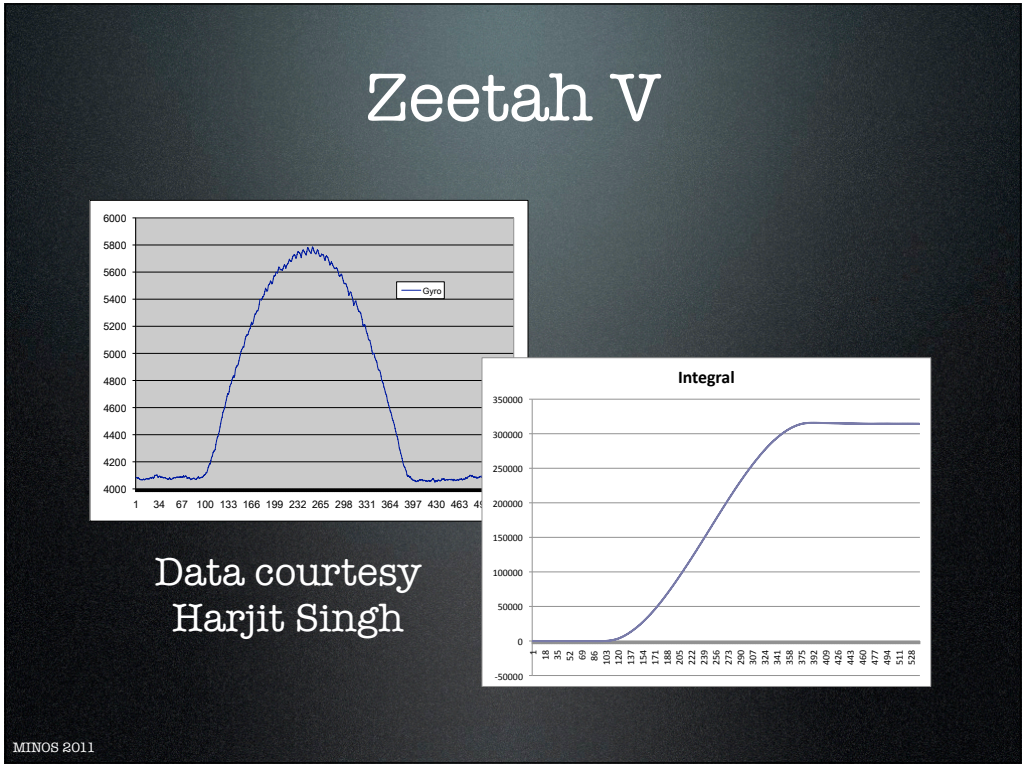
Close agreement between Gyro and encoders.
Time scale incorrectly shown here.



Note that the curve is continuous and has no constant radius portion
integral value depends upon sample rate and ADC resolution

Thank You

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