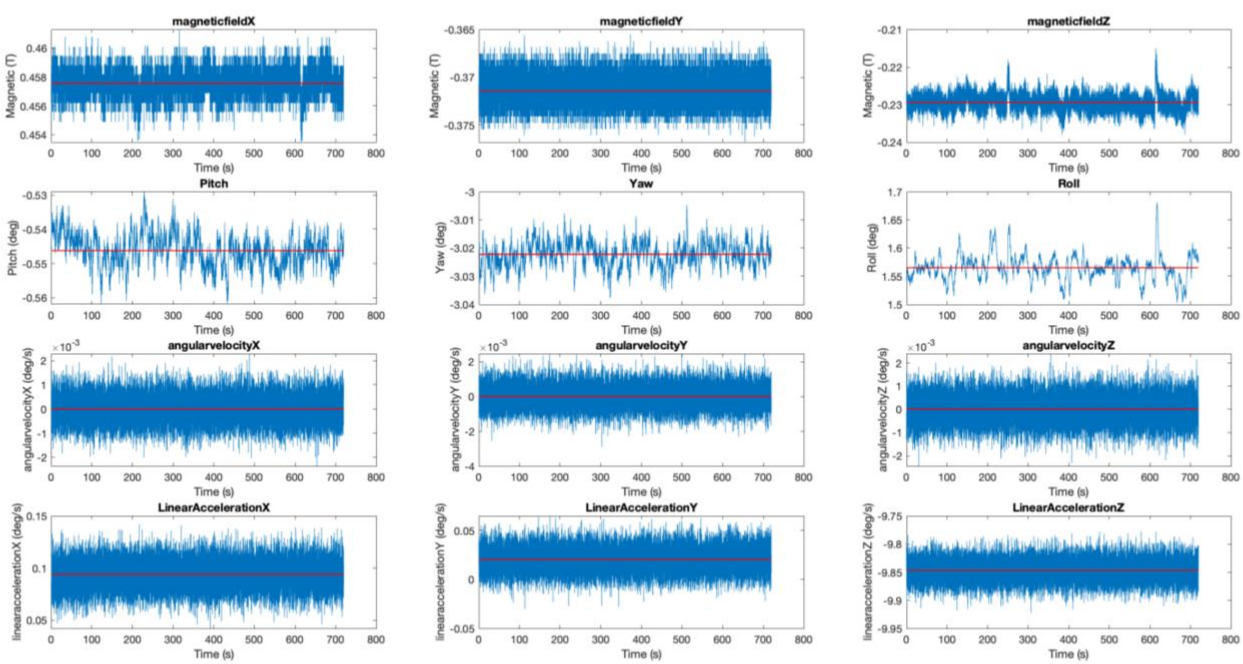
EECE5554 Lab3 Report

1. Stationary noise analysis
   The stationary data was collected for around 10 min, and about 28,000 ros messages were obtained. The table below represent a overview of the noise characteristic of each variables. The standard deviation and mean of Gyro is relatively small, which make sense because we using tips to hold the sensor to make the sensor remains as stationary as possible. The linear acceleration has the highest standard deviation which might caused by the gravitational acceleration, we can also find that the Z axes of the linear acceleration is about -9.84 which is G.

	MagX	**MagY**	**MagZ**	**Pitch**	**Yaw**	**Roll**
Mean	0.45757	-0.37143	-0.22942	-3.02219	-0.54623	1.56524
Standard Deviation	0.00088	0.00154	0.00217	0.00448	0.00478	0.02289
	GyroX	**GyroY**	**GyroZ**	**Linear AccX**	**Linear AccY**	**Linear AccZ**
Mean	-0.0000038	-0.00000083	0.0000028	0.09378	0.02043	-9.8467
Standard Deviation	0.00054	0.00062	0.00057	0.01297	0.01182	0.01821



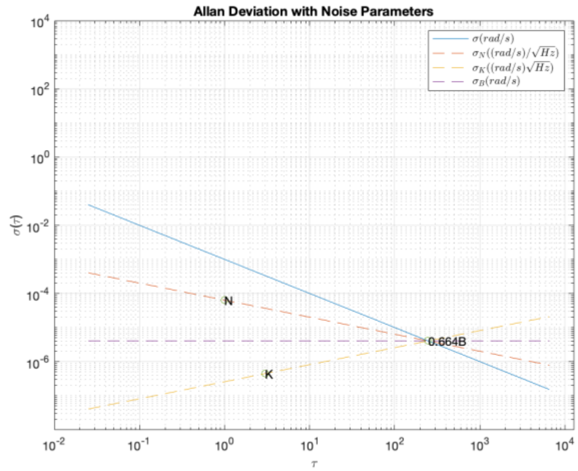
From the figure we can easily notice that the noise density of orientation (pitch, yaw and roll) is much smaller then others, and the average value of angular velocities remain close to zero. These two characteristics indicate that the sensor is sufficiently stable during measuring data.

2. Allan Variance Data Analysis
Allan Variance is a method of analysis in a time domain. It describes variance of a signal as a function of averaging time. The angle random walk is characterized by the white noise spectrum of the gyroscope output where N represents the coefficient of that. The rate random walk is characterized by the red noise (Brownian noise) spectrum of the gyroscope output where K is rate random walk coefficient. And B means bias instability coefficient which characterized by the pink noise (flicker noise) spectrum of the output.

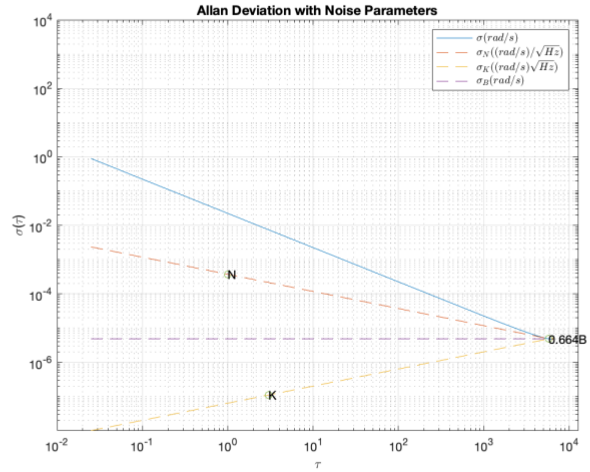
The table and figure below describe the allan variance of different parameter of the IMU, Data were collected for the interval of 5 hours to achieve a reliable estimate of the bias instability. It is obvious that the level of ARW for GyroX is much smaller than others which means the angular velocity X has the best performance in this test. On the other hand, the worst is Gyro Y which output contains bigger amount of high frequency noise.

The noise demonstrated by this result is also known and solved by the manufacturer of the VN100, in datasheet they mentioned that VN-100 uses the accelerometer and magnetometer measurements to continuously estimate the gyro bias, such that the reported angular rates are compensated for this drift. And in the book INERTIAL NAVIGATION PRIMER from VECOTRNAV also have examples on noise calculation which shows different way to convert each of these different noise characteristics to standard deviation.

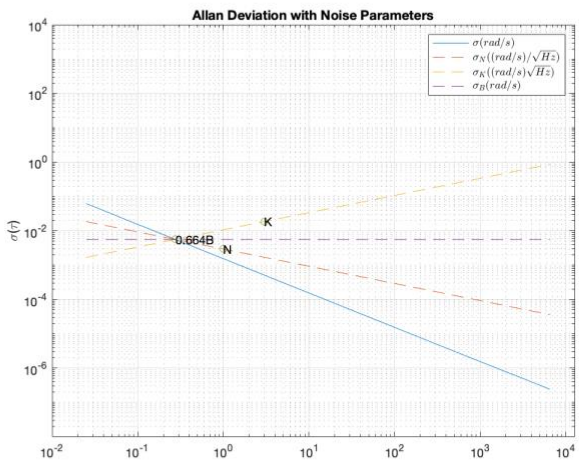
	GyroX	**GyroY**	**GyroZ**
N	6.39353596858234e-05	0.00292902124946164	0.0017011859232309
K	4.47567106703192e-07	0.0184480495291507	0.00785744120575168
B	6.11880385012893e-06	0.00840820677788028	0.0041819935103213
	Linear AccX	**Linear AccY**	**Linear AccZ**
N	0.000370139876038513	0.00199409566866428	0.000442003685257362
K	1.10037516899616e-07	3.37210155067569e-05	1.32507068678765e-07
B	7.26944236660857e-06	0.000296613020774598	8.75385528562293e-06



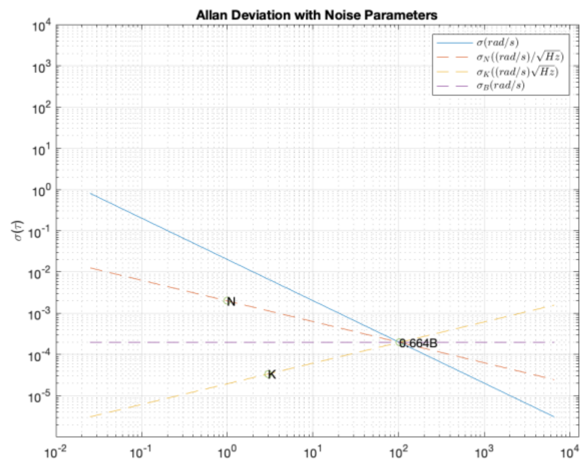
AngularVelocityX



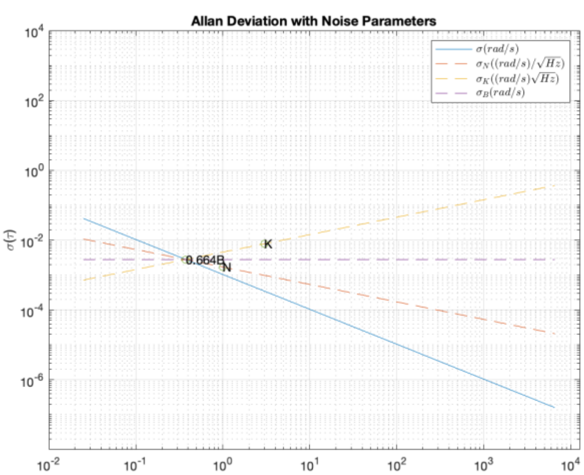
LinearAccelerationX



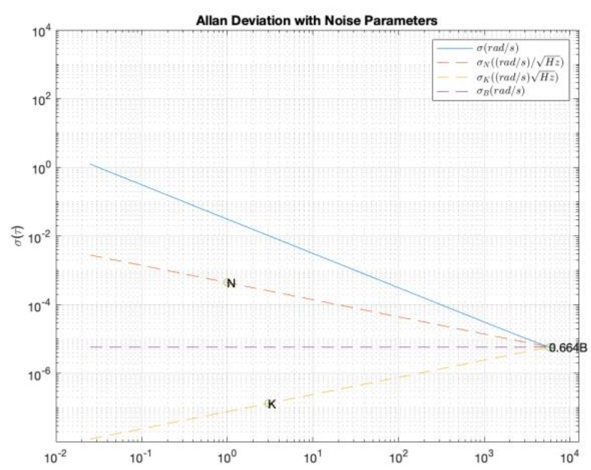
AngularVelocityY



LinearAccelerationY



AngularVelocityZ



LinearAccelerationZ