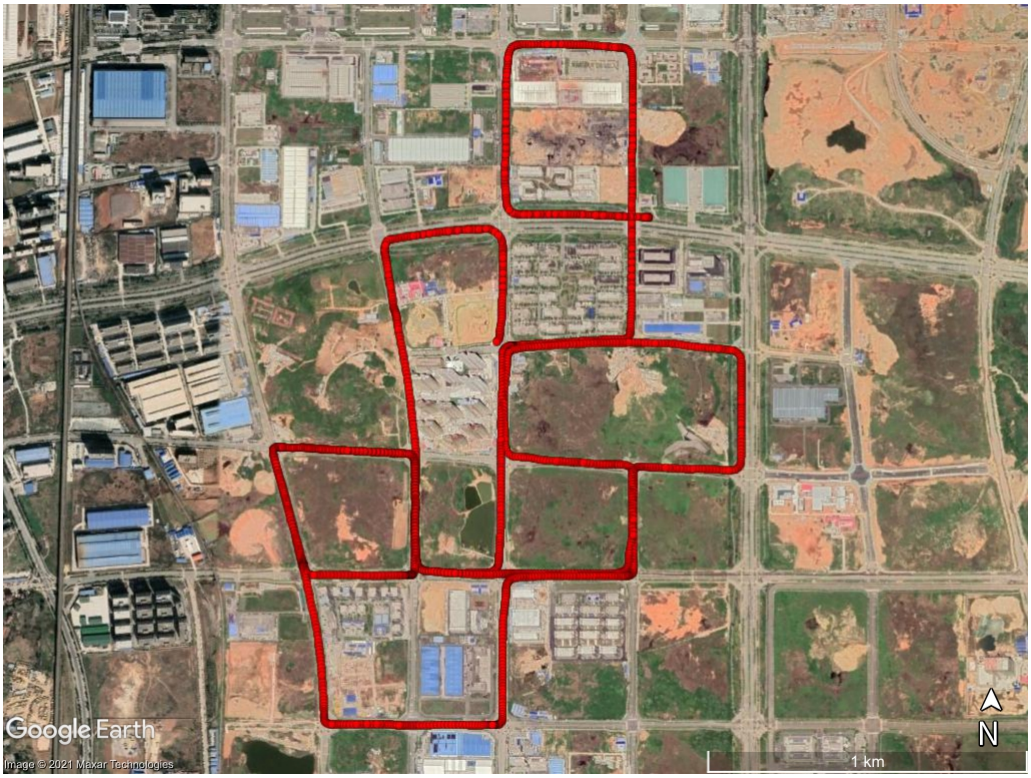
Awesome GINS Dataset

An awesome vehicle GINS dataset for GNSS/INS integration applications



This repository provide an awesome GINS dataset for GNSS/INS integration applications. The biggest feature of the dataset is that four different grade of MEMS IMUs are included, which provide an opportunity for the researchers to comprehensively evaluate their algorithms.

The dataset was collected in an open-sky industrial area, where the GNSS RTK was well satisfied. The duration of the whole dataset is 1617 seconds, including the raw IMU data, GNSS RTK positioning results, and the ground-truth for each IMU.

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Related Paper:

- Hailiang Tang, Xiaoji Niu, Tisheng Zhang, Jing Fan, and Jingnan Liu, “Exploring the Accuracy Potential of IMU Preintegration in Factor Graph Optimization,” Sep. 2021, Accessed: Sep. 08, 2021. [Online]. Available: https://arxiv.org/abs/2109.03010v1

If you use this dataset for your academic research, please cite our related papers; and give acknowledgement like:

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English version: “The authors would like to acknowledge Dr. Xiaoji Niu and the Integrated and Intelligent Navigation (i2Nav) group from Wuhan University for providing the GNSS/INS dataset that was used in the paper.”
中文模板：“本文作者感谢武汉大学多源智能导航实验室和牛小骥教授提供了本文所需的GNSS/INS数据集。”
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Explanation: GitHub do not support Latex formula, and we suggest you read the document with a local Markdown editor, e.g. **Typora**.

1 The MEMS IMU

Four MEMS IMUs are included in this dataset, and the details about these IMUs are listed as follows:

IMU	Description	Vendor	Gyroscope Bias Instability (Allan Variance) [deg/hr]
ICM20602	consumer-grade chip	InvenSense	10.0
ADIS16460	industrial-grade module	Analog Devices Inc.	8.0
ADIS16465	industrial-grade module	Analog Devices Inc.	2.0
HGuide-i300	industrial-grade module	Honeywell	3.0

We also provide a set of noise parameters for each IMU, which are obtained by conducting parameter tuning. Specifically, the IMU measurements are defined as follows:

$$\begin{aligned} \tilde{\boldsymbol{f}}^{\mathrm{b}} &= \boldsymbol{f}^{\mathrm{b}} + \boldsymbol{b}_a + \boldsymbol{n}_a, \\ \tilde{\boldsymbol{w}}_{\mathrm{ib}}^{\mathrm{b}} &= \boldsymbol{w}_{\mathrm{ib}}^{\mathrm{b}} + \boldsymbol{b}_g + \boldsymbol{n}_g \end{aligned} \tag{1}$$

where the additive noise $\boldsymbol{n}_a$ and $\boldsymbol{n}_g$ are modeled as Gaussian white noise processes; $\boldsymbol{b}_a$ and $\boldsymbol{b}_g$ are respectively the accelerometer and gyroscope biases, which are modeled as first-order Gaussian Markov processes. The IMU noise model can be expressed as follows:

$$\begin{aligned} \boldsymbol{n}_g &\sim \mathcal{N}\left(\boldsymbol{0}, \sigma_g^2 \boldsymbol{I}\right), \\ \boldsymbol{n}_a &\sim \mathcal{N}\left(\boldsymbol{0}, \sigma_a^2 \boldsymbol{I}\right), \\ \delta \dot{\boldsymbol{b}}_{g_t} &= -\frac{1}{\tau_{b_g}} \delta \boldsymbol{b}_{g_t} + \boldsymbol{n}_{b_g}, \boldsymbol{n}_{b_g} \sim \mathcal{N}\left(\boldsymbol{0}, \sigma_{b_g}^2 \boldsymbol{I}\right), \\ \delta \dot{\boldsymbol{b}}_{a_t} &= -\frac{1}{\tau_{b_a}} \delta \boldsymbol{b}_{a_t} + \boldsymbol{n}_{b_a}, \boldsymbol{n}_{b_a} \sim \mathcal{N}\left(\boldsymbol{0}, \sigma_{b_a}^2 \boldsymbol{I}\right) \end{aligned} \tag{2}$$

The reference noise parameters are listed as follows:

IMU	Angle Random Walk σ_g [$deg/\sqrt{hr}$]	Velocity Random Walk σ_a [$m/s/\sqrt{hr}$]	Gyroscope-bias Standard Deviation σ_{b_g} [deg/hr]	Accelerometer-bias Standard Deviation σ_{b_a} [$mGal$]	Correction Time σ_g, σ_a [hr]
ICM20602	0.2	0.2	200	1000	1
ADIS16460	0.2	0.1	20	100	1
ADIS16465	0.1	0.1	25	200	1
HGuide-i300	0.2	0.2	15	150	1

2 Installation parameters

The IMU body frame (b-frame) is defined as forward-right-down (FRD) coordinate. The GNSS geodetic positioning is defined in WGS-84 ellipsoid model. The GNSS antenna lever-arms in b-frame are listed as follows:

IMU	**Lever-arms (FRD) [m]**
ICM20602	-0.073, 0.302, 0.087
ADIS16460	0.045, 0.46, -0.238
ADIS16465	-0.073, 0.302, 0.087
HGuide-i300	-0.075, 0.46, -0.218

3 File format descriptions

Three type of files are contained in the dataset, including the IMU binary file, the GNSS positioning result text file, and the ground-truth text file.

The IMU binary file format (*.bin) is defined as:

Field	**Type**	**Bytes**	**Description**	**Units**
1	double	8	GNSS seconds of week	s
2	double	8	incremental angle x axis	rad
3	double	8	incremental angle y axis	rad
4	double	8	incremental angle z axis	rad
5	double	8	incremental velocity x axis	m/s
6	double	8	incremental velocity y axis	m/s
7	double	8	incremental velocity z axis	m/s

The GNSS positioning result text file (*.pos, 7 columns) is defined as:

Field	**Description**	**Units**
1	GNSS seconds of week	s
2	geodetic latitude	deg
3	geodetic longitude	deg
4	geodetic height	m
5	latitude standard deviation	m
6	longitude standard deviation	m
7	height standard deviation	m

The ground-truth text file (*.nav) is defined as:

Field	Description	Units
1	GNSS week	-
2	GNSS seconds of week	s
3	geodetic latitude	deg
4	geodetic longitude	deg
5	geodetic height	m
6	velocity in north direction	m/s
7	velocity in east direction	m/s
8	velocity in down direction	m/s
9	roll attitude	deg
10	pitch attitude	deg
11	yaw attitude	deg