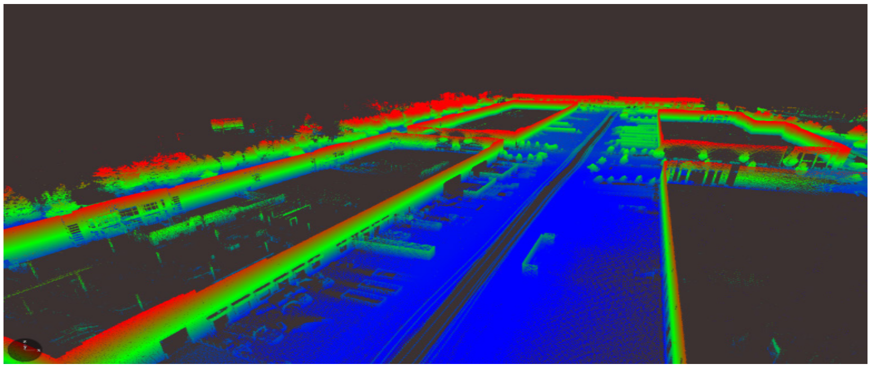
Inertial Labs
Attitude is Everything

GPS-Aided Inertial Navigation Systems (INS)
for Remote Sensing

EVOLUTION OF REMOTE SENSING

Remote sensing emerged more than 150 years ago, as balloonists took pictures of the ground using the recently invented photo cameras in the 1840s. Perhaps the most memorable breakthrough in the field at the end of the 19th century was the famous fleet of pigeons that operated as innovation in Europe, taking pictures with cameras attached to their bodies. By the First World War, cameras mounted on airplanes provided aerial views of vast surface areas that proved to be invaluable in military reconnaissance. The aerial photograph remained the single standard tool for imaging the surface up until the early 1960s.

AREA MAPPING



The latest progress in laser and microprocessor technologies have ignited an emerging generation of affordable and compact mapping solutions which are being employed by a number of businesses across industries including construction, agriculture, surveying, mining, and more. Nowadays remote sensing is performed on various moving bases including cars, drones and on robots like LS3 by Boston Dynamics. Automakers rushing to come up with the most efficient self-driving cars encourage to employ remote sensing technologies as never before.

Perhaps area mapping is still the biggest domain for remote sensing. Making sense of the physical world by analyzing maps and 3D models allows businesses to make faster and more informed decisions that increase efficiency, profit and more importantly, improve safety. Few of the most often used bases it can be done on are a land vehicle or Unmanned Aerial Vehicles (UAV). Both options come with their own pros and cons.

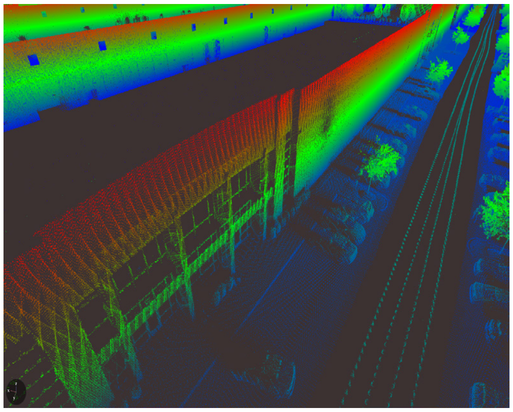
MULTIROTOR	FIXED-WING
GOOD AT	GOOD AT
Maneuverability	Flying range
Affordable price	Stability
Compact size	Vibration
Ease-to-use	Linear flight
Payload capacity	
DRAWBACKS	DRAWBACKS
Vibration	Larger take-off zone
Wind	Higher price
Flying range	Challenging to fly
	Size

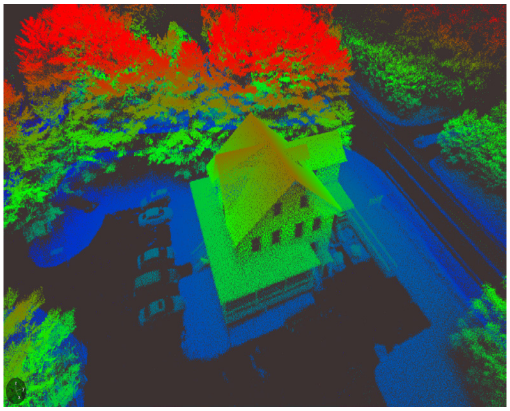
CHOOSE THE RIGHT DRONE

Even though a land vehicle is able to cover vast areas, a disadvantage is there are many places to be mapped have impassable surfaces, like jungles or rocky mountains. With prices for UAVs going down, it's no surprise that drone use is on the rise as an alternative for capturing aerial data and to generate accurate 3D models of surroundings.

IMPORTANCE OF PRECISION POINT CLOUD

Accurate precision point clouds are the most critical aspect of remote sensing. Reaching maximum accuracy for point clouds over the minimum scans is an ultimate goal. The key requirement is the reliability of gathering data and raw data accuracy. Depending on nature of your business you may need data transmitted in real-time, or need it recorded for post processing. Ultimately, you'll need to decide which approach is best for your business needs. In the case of real time data processing, you sacrifice accuracy. Highly accurate real time data processing is possible, though there is more chance for errors and the accuracy will always be worse than post processing the data. Generally, accuracy is expected to be poorer when using real time methods and the accuracy requirements of the project will dictate whether real time methods can be used. When precision is the topmost priority, post processing is the method to use.

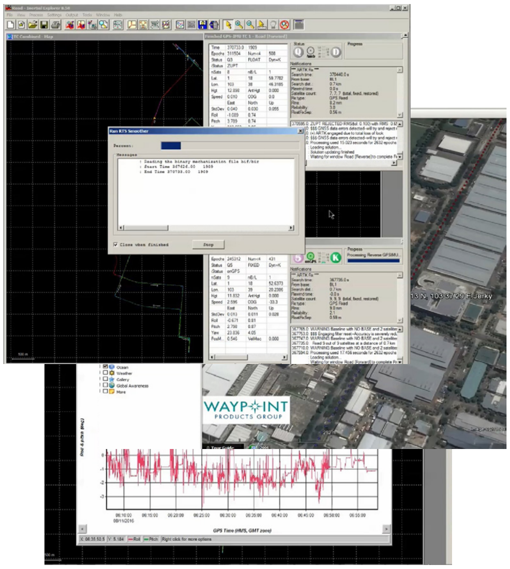




THERE IS NO ONE SIZE FITS ALL

POST-PROCESSING SOFTWARE

If your resources are invested in post processing, then you can slightly sacrifice point cloud accuracy while gathering data. There are several powerful software packages designed for post processing to compensate for lost points by extrapolating some amount of data. One example of such is Inertial Explorer®(1) developed by NovAtel Inc. Waypoint Products Group. It's a Windows-based suite of programs that provide GNSS (Global Navigation Satellite System) and inertial data post-processing. It may come preconfigured with aerial, land vehicle and marine processing profiles that help new customers get started quickly.



WAYPOINT PRODUCTS GROUP

For post processing, you need an INS with raw data and the ability to log GNSS raw data plus inertial data. You also need access to good base station data. No matter what, whether it's a land vehicle or a drone, the core element for a remote sensing solution is a GPS-Aided INS.

LiDAR

Sometimes called 3D laser scanner, LiDAR is a surveying method that measures distance to a target by illuminating the target with pulsed laser light and measuring the reflected pulses with a sensor. It has terrestrial, airborne, and mobile applications. Some models of 3D LiDAR are able to generate up to 700,000 data points per second, There are plenty of exceptional producers on the market, for example Quanergy®(2) and Velodyne®.

GENERAL SPECIFICATIONS

Channels	16
Measurement Range	100 m
Range Accuracy	Up to ±3 cm
Vertical Field of View	30°
Vertical Angular Res	2.0°
Horizontal Field of View	360°
Horizontal Angular Res	0.1° – 0.4°
Rotation Rate	5 Hz – 20 Hz

(1) Inertial Explorer® is a registered trademark of NovAtel Inc, Waypoint Products Group.
(2) Velodyne® is a registered trademark of Velodyne LiDAR, Inc.
** LiDAR USA® is a registered trademark of Fagerman Technologies Inc.

GPS-AIDED INS

Based on cost-effective MEMS technology, the Inertial Labs Single and Dual Antenna GPS-Aided INS is a new generation of fully-integrated, high-performance strapdown systems. Inertial Labs GPS-Aided INS utilizes a GNSS receiver produced by NovAtel®, barometer, 3-axes each of temperature calibrated precision, tactical grade Accelerometers, and Gyroscopes to provide accurate orientation. Inertial Labs GPS-Aided INS contains new on-board sensor fusion filter, state of the art navigation and guidance algorithms, and calibration software.

Single GNSS antenna INS for post processing kinematics (PPK)

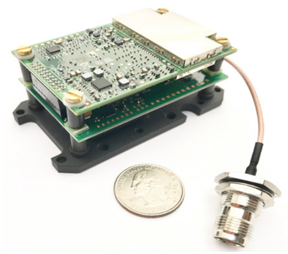
Position accuracy = 0.5 cm

Heading accuracy = 0.03°

Pitch & Roll accuracy = 0.006°

Velocity accuracy = 0.01 m/sec

GPS-Aided INS-B



GPS-Aided INS-B-OEM

Dual GNSS antenna INS for real time kinematics (RTK)

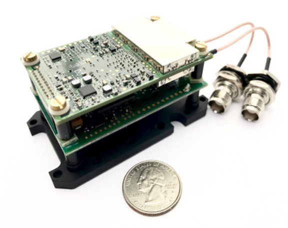
Position accuracy = 1 cm

Heading accuracy = 0.1°

Pitch & Roll accuracy = 0.05°

Velocity accuracy = 0.03 m/sec

GPS-Aided INS-D



GPS-Aided INS-D-OEM

Depending on specific needs, the GPS-Aided INS comes within different parameters to match your business goals in the most efficient way. A wide spectrum of options are available in the INS-B product line. Inertial Labs has got you covered. Inertial Labs possesses experience in delivering not just GPS-Aided INS, but also the complete payload (Remote Sensing Payload Instrument – RESEPI.)

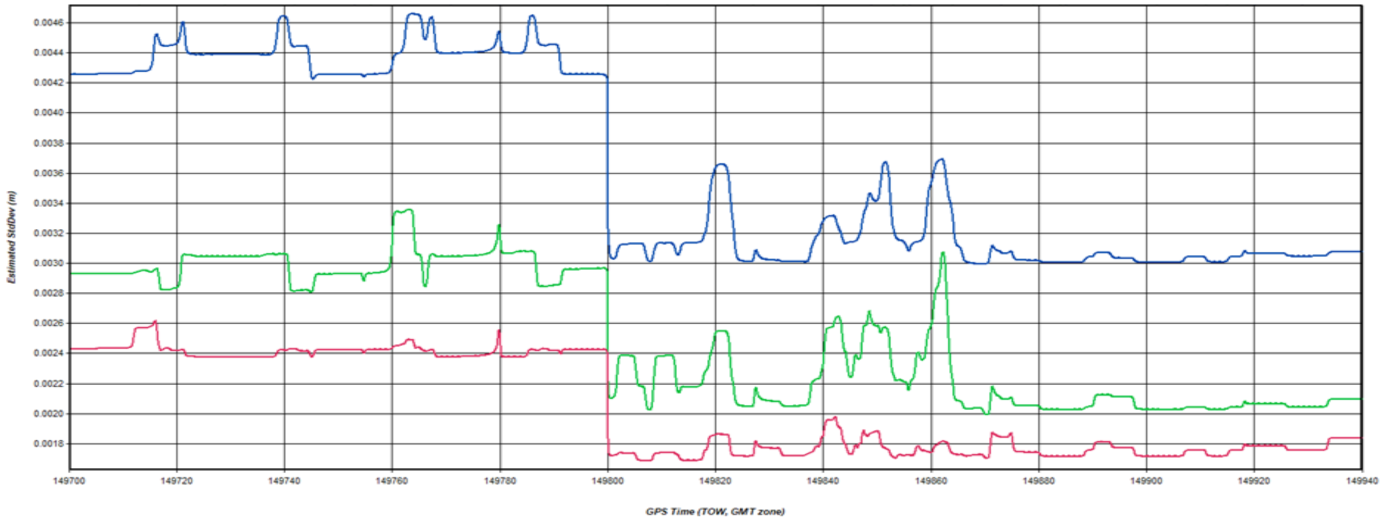
TEST RESULTS

INS MODEL : INS-B
FLYING PLATFORM : DJI Matrice 600 Pro
GNSS RECEIVER : NovAtel® OEM-7
TYPE OF IMU : 1°/h, Tactical Grade
POST-PROCESSED : Inertial Explorer® software

POSITION

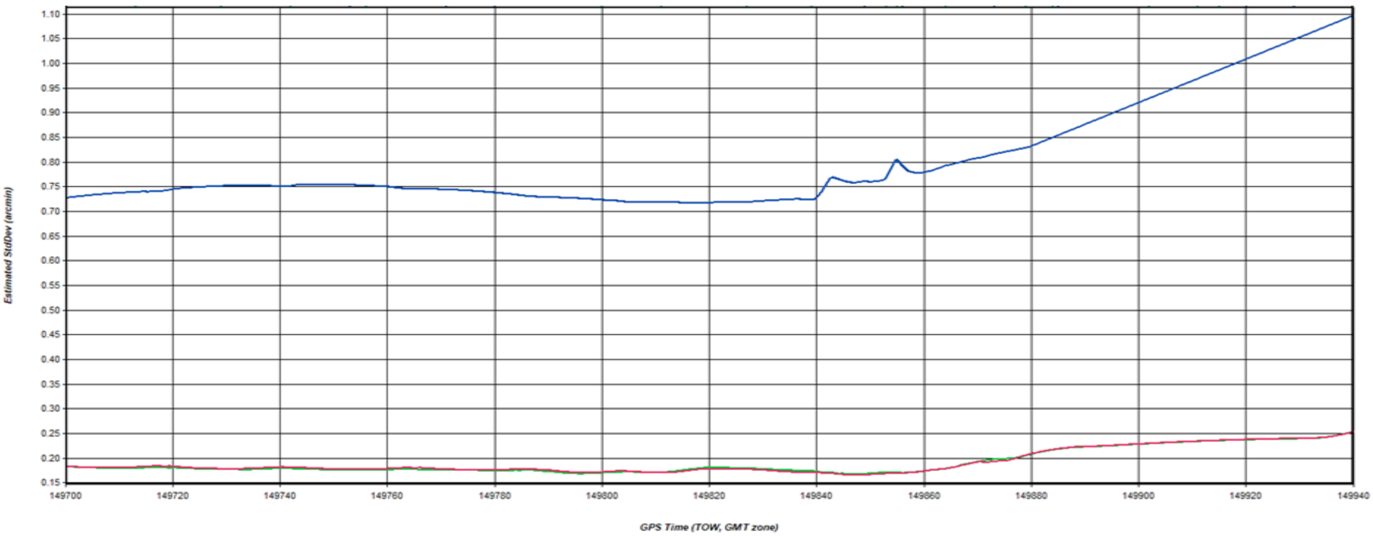
Position accuracy	East, meters	North, meters	Height, meters
STD	0.00033	0.00044	0.00064
RMS	0.00206	0.00255	0.00370
Mean	0.00204	0.00252	0.00364

POSITION ACCURACY PLOT



Attitude accuracy	Heading, arc min	Pitch, arc min	Roll, arc min
STD	0.1041	0.0248	0.0248
RMS	0.8086	0.1921	0.1925
Mean	0.8019	0.1905	0.1909

ATTITUDE ACCURACY PLOT



TO SUM UP

The major goal in remote sensing is to pick right set of core elements, to integrate them into a solution and as a result, to achieve desired precision point cloud. Last but not least, all must be done within the shortest period of time and at the lowest price, so not to exceed the budget.

Set of core elements for remote sensing are the same whether it's a solution for surveying power line corridor, pipeline inspection, precision agriculture etc. While there are plenty of products on the market to choose from, the roadmap to a successful outcome goes through several critical points:

Choosing Software

Depends if nature of your application is being designed for:

- **Post Processing**
- **Real Time**

Choosing Moving Base

Depends on many factors. Options are:

- **Multirotor UAV**
- **Fixed-wing UAV**
- **VTOL Drone**
- **Land Vehicle**

Choosing LiDAR

Major decision factors:

- **Range**
- **Power usage**
- **Size and weight**
- **Price**

Choosing GPS-Aided INS

Major decision factors:

- **Accuracy**
- **Power usage**
- **Size and weight**
- **Price**

The seasoned team of experts at Inertial Labs will not only help you to choose the right elements, but also provide assistance and support through every stage of integration.

Remote Sensing has an increasing significance in the modern society. Data for civil, research, and military purposes is being gathered and processed for better decision making. Photogrammetry, area mapping, surveying, inspection, and reporting are just few examples of remote sensing applications. According to Market Research Future Analysis, global remote sensing technology market has been valued at approximately $18 Billion by the end of forecast period, from 2018 to 2023.

About Inertial Labs Inc.

Established in 2001, Inertial Labs is a leader in position and orientation technologies for commercial, industrial, aerospace and defense applications. Inertial Labs has a worldwide distributor and representative network covering 20+ countries across 6 continents and a standard product line spanning from Inertial Measurement Units (IMU) to GPS-Aided Inertial Navigation Systems (INS). With application breadth on Land, Air, and Sea; Inertial Labs covers the gambit of inertial technologies and solutions.

MADE IN USA

Inertial Labs
Attitude is Everything

Scan me!!!

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