

An aerial photograph of a winding road through a forest, with a parking lot and some buildings visible on the left side. The image is partially obscured by orange geometric shapes.

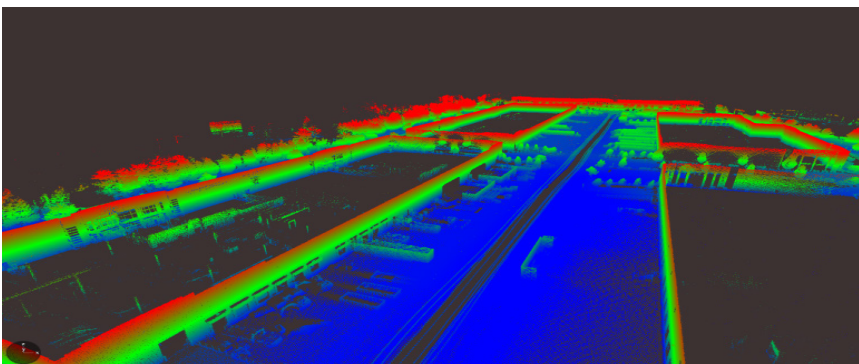
GPS-Aided Inertial Navigation Systems (INS) for Remote Sensing

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



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.

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.





MULTIROTOR

GOOD AT

Maneuverability
Affordable price
Compact size
Ease-to-use
Payload capacity

DRAWBACKS

Vibration
Wind
Flying range



FIXED-WING

GOOD AT

Flying range
Stability
Vibration
Linear flight

DRAWBACKS

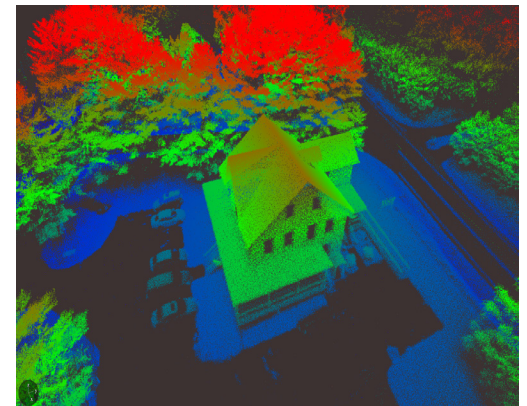
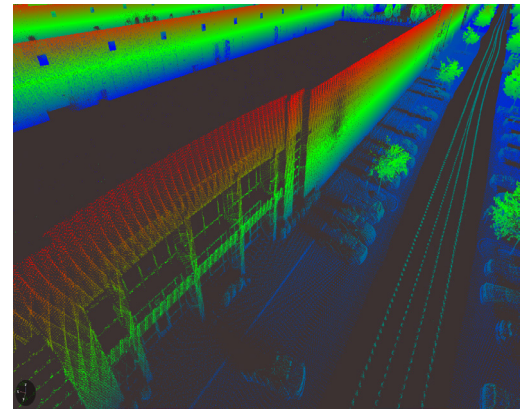
Larger take-off zone
Higher price
Challenging to fly
Size

CHOOSE THE RIGHT DRONE

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

IMPORTANCE OF PRECISION POINT CLOUD

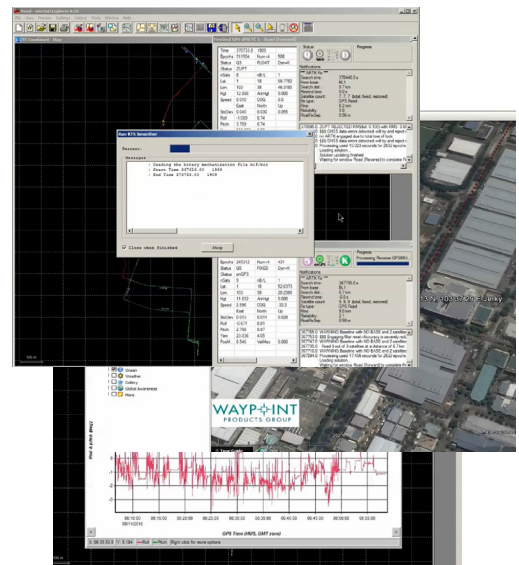
Accurate precision point cloud is the most critical aspect of remote sensing. Reaching maximum accuracy of the point clouds over minimum times of surveying is an ultimate goal. Key requirement is reliability of gathered data and raw data accuracy. Depending on nature of your business you may need data transmitted in real-time, or need it belatedly for post processing. Ultimately, you'll need to decide which approach is best for your business needs. In case of Real Time data output, you sacrifice accuracy. Highly accurate Real Time data gathering is possible, though would be more expensive to achieve. Generally, accuracy is expected to be poorer than after post-processing, especially measuring attitude. Some gather data solely for post processing, and even then precision is the topmost priority.



THERE IS NO ONE SIZE FITS ALL

POST-PROCESSING SOFTWARE

If your resources are invested in post processing, then you may 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



No matter what a moving base is suitable for your business, whether it's a land vehicle or a drone, the core set of elements for remote sensing solution are, LiDAR and most importantly GPS-Aided INS with embedded data logger.

LiDAR



Sometimes called 3D laser scanner, LiDAR is a special combination of a 3D and laser scanning types of equipments. It has terrestrial, airborne,

and mobile applications. Some models of 3D LiDAR are able to generate up to 700,000 data points per second, 360° horizontal and 30° vertical fields of view. There are plenty of exceptional producers on the market, for example Velodyne^{®(2)}.



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

GPS-AIDED INS

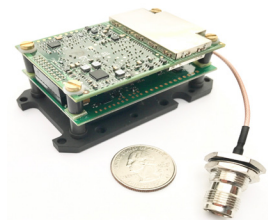
Based on cost-effective MEMS technology, the Inertial Labs Single and Dual Antenna GPS-Aided INS is a new generation of fully-integrated, high-performance strapdown systems. Inertial Labs GPS-Aided INS utilizes GNSS receiver produced by NovAtel®, barometer, 3-axes each of calibrated in full operational temperature range precision, tactical grade Accelerometers, and Gyroscopes to provide accurate orientation. Inertial Labs GPS-Aided INS contains new on-board sensors 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



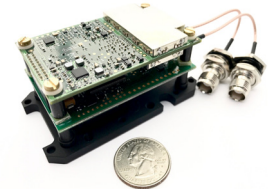
GPS-Aided INS-B-OEM

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, GPS-Aided INS comes within different parameters to match your business goals in the most efficient way. Spectrum of modifications presented in product line of Inertial Labs has got you covered. Inertial Labs possesses experience in delivering not just GPS-Aided INS, but also complete payload (Remote Sensing Payload Instrument – RESEPI)

TEST RESULTS

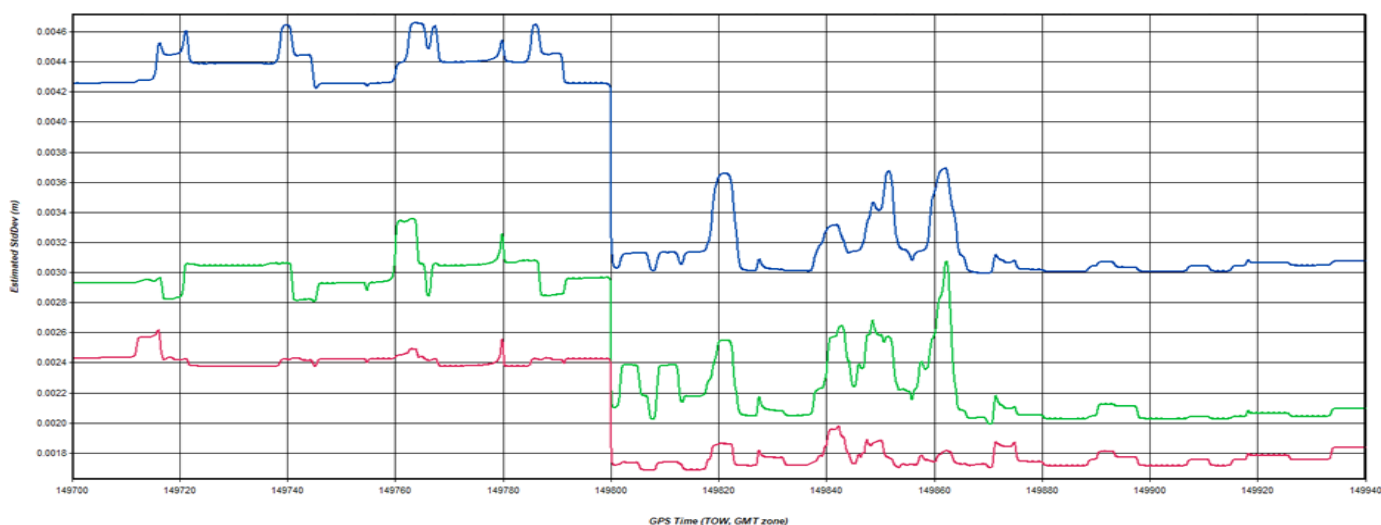
INS MODEL : INS-B
 FLYING PLATFORM : DJI Matrice 600 Pro
 GNSS RECEIVER : NovAtel® OEM-7
 TYPE OF IMU : 1°/h, Tactical Grade
 POST-PROCESSED : Inertial Explorer® software



POSITION

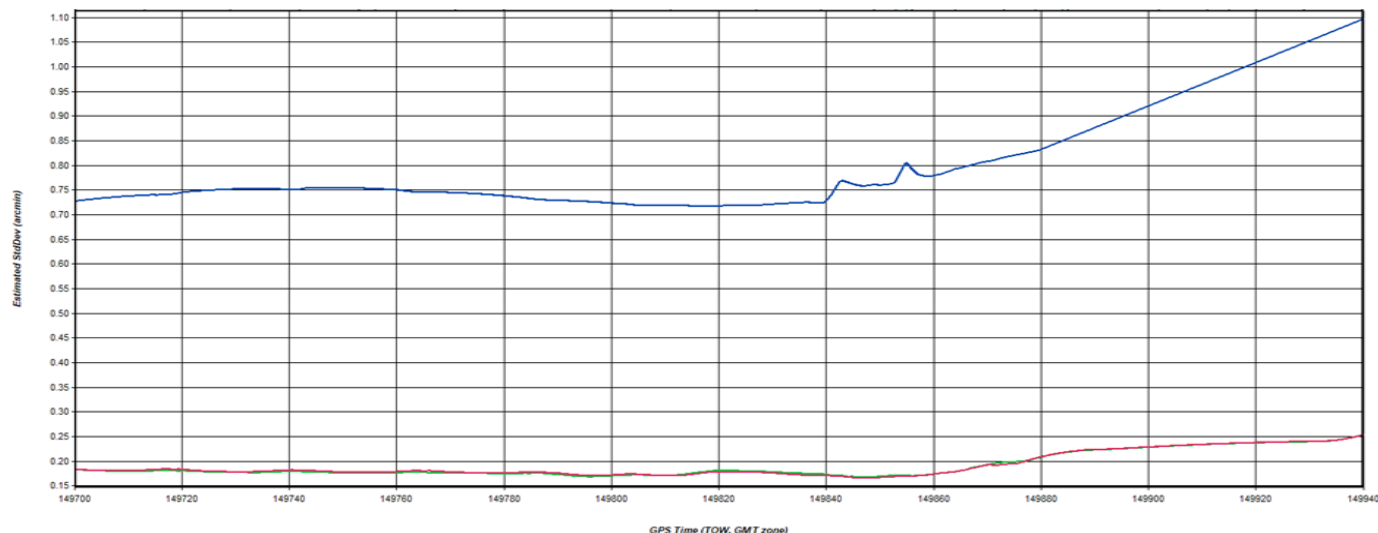
Position accuracy	East, meters—	North, meters—	Height, meters—
STD	0.00033	0.00044	0.00064
RMS	0.00206	0.00255	0.00370
Mean	0.00204	0.00252	0.00364

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 step out of 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 are presented on the market to choose from, roadmap to successful outcome goes through several critical decisions to be made:

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**



Seasoned team of experts from Inertial Labs will not only help you to choose right elements, but also provide assistance and support through all stages 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. Photometry, area mapping, reports on climate change or natural disasters 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 both commercial/industrial and aerospace/defense applications. With a worldwide distributor and representative network covering 20+ countries across 6 continents, a standard product line spans from Inertial Measurement Units (IMU) up to GPS-Aided Inertial Navigation Systems (INS) with application breadth on Land, Air, and Sea; Inertial Labs covers the gambit of inertial technologies.



Scan me!!!

Inertial Labs, Inc.
39959 Catoctin Ridge Street,
Paeonian Springs, VA 20129 U.S.A.
phone: +1(703) 880 4222
e-mail: sales@inertiallabs.com
www.inertiallabs.com