Navigation Doppler Lidar

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Overview

Navigation Doppler Lidar (NDL) is a laser-based sensor capable of providing precision vehicle velocity vector and altitude. The lidar data is used by an autonomous Guidance, Navigation, and Control (GN&C) system to precisely navigate the vehicle and execute a gentle touchdown.

Potential Users

- Landing missions to the Moon, Mars, and beyond
- Asteroid sample return and redirect missions
- Automatic Rendezvous and Docking (AR&D)
- Satellite servicing missions
- Helicopter operation in Degraded Visual Environment
- Aircraft operation in GPS-Denied Environment
- Aircraft landing on seaborne platforms

NDL is a Viable Replacement for Radars

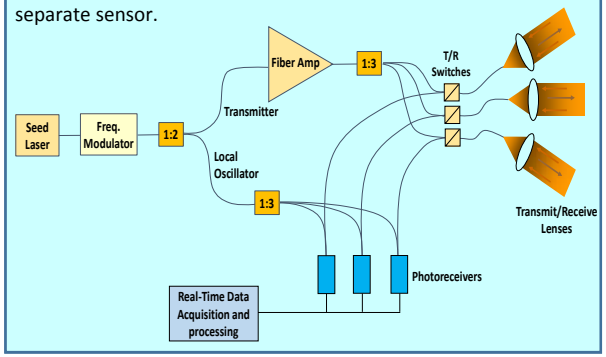
- An order of magnitude higher precision
- Reduced size and weight
- Insensitive to terrain features
- No signal ambiguity from transmitted side lobes
- No signal clutter from jettisoned components

NDL Enables Higher Performance, Lower Risk, and Lower Cost Landing Capabilities

- **"*Well-controlled*" maneuvering to within a few cm/sec**
  - Precise execution of descent and landing sequence → fuel saving
  - Reduced touchdown impact loads → lower lander mass
- **"*Precision navigation*" to designated landing location**

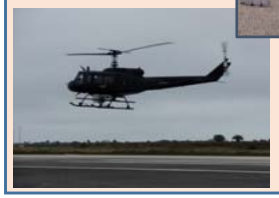
NDL Sensor Description

The NDL transmits three laser beams in fixed directions relative to each other. The signal from each beam provides the platform velocity and range to the ground along the laser line-of-sight (LOS). The three simultaneous LOS measurements are then combined to determine the three components of the vehicle velocity vector, and to accurately measure its altitude relative to the local ground without the need for attitude angle data from a separate sensor.



Flight Tests

The NDL operation has been characterized through extensive testing including ground tests, 3 helicopter flight test campaigns, 6 flights on rocket-powered Morpheus vehicle, and 2 flights on Masten Xodiac vehicle.



Prototype NDL

Electronic chassis *houses all the lidar components (laser, receiver, PDU, controller, and signal processor).*

Optical head *consists of three transmit/receive lenses connected to the chassis via a long fiber optic cable.*

NDL Specifications		
LOS Velocity Error		0.2 cm/sec
LOS Range Error		30 cm
Maximum LOS Range		> 4.5 km
Maximum LOS Velocity		200 m/sec
Data Rate		20 Hz
Dimensions	Electronic Chassis	28 x 22 x 20 cm
	Optical Head	34 x 33 x 21 cm
Mass	Electronic Chassis	8.7 kg
	Optical Head	5 kg
Power (28 VDC)		80 W

Navigation Doppler Lidar (NDL)

- Measures velocity and range along three different laser beams
- Simultaneous line-of-sight measurements are used to determine:
  - Velocity Vector (V)
  - Attitude relative to local ground
- Viable replacement for radars
  - An order of magnitude higher precision
  - Lower size, weight, cost, and risk

Parameter	GEN 3
Maximum LOS Velocity	200 m/sec
Maximum LOS Range	> 4 km
LOS Velocity Error	1.7 cm/sec
LOS Range Error	2.2 m
Data Rate	20 Hz

GEN 3 NDL

Chassis	**11”x9”x8”**	**8.7 kg**
Optical Head	**2” lenses**	**5kg**

- NDL has been extensively tested:
  - 3 helicopter flight test campaigns
  - 6 flights on rocket-powered free-flyer Morpheus vehicle (GEN 2 NDL)
  - 2 flights on Xodiac rocket-powered free-flyer vehicle (GEN 3 NDL)
- Spaceflight Engineering Test Unit (ETU) will be completed by the end of 2018