INFRARED SPECKLE-TRACKING SENSOR

WHAT IS

The VIS - *Speckle tracking Infrared Vibrometer* - is an instrument for remote measurement of vibrations that characterize the behaviour of structures subjected to dynamic loads. With a laser emission around 1 mW the device is able to detect target vibrations induced by micro-seismicity, wind, traffic and other human activities.

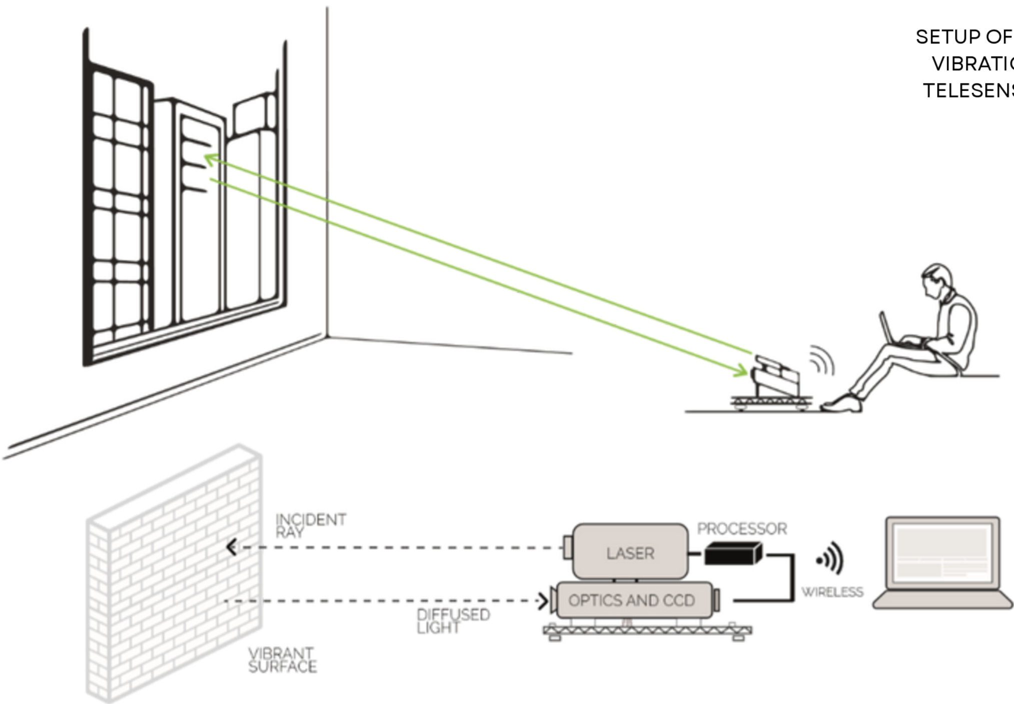
Unlike other "in situ" sensors, it can be positioned up to 100 meters from the surface to be monitored and does not need to be positioned perpendicular to the target surface, ensuring accurate measurements even in areas that are difficult to access.

OPERATING PRINCIPLES

The main feature that distinguishes VIS from other optical vibration sensors is that it is based on the reception of light scattered from the target surface. When coherent laser light illuminates a rough surface, a random diffraction image is produced, known as a speckle pattern, which is extremely sensitive to microscopic details on the reflecting surface. Vibrations in the structure change the inclination of the illuminated surface and, consequently, the speckle pattern. The received scattered light beam is adjusted and projected onto optical sensors in order to detect angular velocities and other derived quantities in VIS-1 and spatial shifts in VIS-2.

TECHNICAL SPECIFICATIONS

The VIS is a compact, lightweight instrument comprising a laser, an optical system consisting of a distance-adjustable lens and lenses capable of modifying the received light beam, and one or two optical sensors connected to a minicomputer for acquiring and processing data for vibration analysis. Data transfer to and from the VIS can be done wirelessly through SSH protocol or via a direct connection.



SETUP OF THE VIBRATION TELESENSOR

Watch VIS video

VIS 1

The instrument operates in the near-infrared (NIR) wavelength range, where oxygen molecules exhibit strong environmental radiation absorption, greatly enhancing the signal reading and allowing measurements to be taken in maximum sunlight at midday or in other bright conditions. The received scattered light beam is split, compressed and projected onto two linear optical sensors providing increased brightness and processing speed for greater resilience to disturbances caused by dust and air fluctuations. By detecting angular velocities, the system can capture even small rotations of the observed surface, which often precede or accompany structural instabilities. Measuring angular motion makes the instrument particularly effective for monitoring slender elements such as poles, towers or bridge decks, where tilting is a sensitive indicator of damage or excessive loading. The use of angular velocity also allows the device to distinguish out of plane measurements for diagnostic reliability in real structural health monitoring scenarios.

VIS 2

The instrument operates in the green color range of the visible light spectrum, where the shorter wavelength favors higher speckle contrast and enables enhanced displacement sensitivity. Measuring translations enables the direct evaluation of the absolute movement of large surfaces, such as building facades or bridge spans, which is fundamental to quantify deflections and oscillations under dynamic loads. Translational motion detection provides an immediate interpretation of the in plane measurements of structural vibrational response.

Size L x W x H	300 mm x 100 mm x 100 mm
Bandwidth	0 - 300 Hz
Operating distance	up to 100 m
Operability	on all rough surfaces (masonry, cement, wood, metals) also during sunlight
Angular velocity [1]	from 10 μrad/s to 0.1 rad/s
Angular displacement [1]	from 0.1μrad to 1.5 mrad
Spatial Resolution [2]	0.24 μm
Velocity Sensitivity [2]	1.5 μm/s

[1] *VIS - 1 Measures angular quantities*
[2] *VIS -2 Measures linear quantities*

BACKED BY INNOVATION SINCE 2020

SpacEarth Technology is supported by four patents, reflecting a solid track record of innovation and excellence that started in 2020:

- *Telesensore a tracciamento di speckle utilizzante un accelerometro ottico-inerziale, e metodo di correzione del rumore vibrazionale di tale telesensore* (102020000006703) -31/3/2020
- *Telesensore di vibrazione a tracciamento di speckle con doppio ricevitore ottico e metodo di correzione del rumore vibrazionale di tale telesensore* (102023000016242) - 1/8/2023
- *Vibrometro a tracciamento di speckle a ridotta intensità di emissione luminosa* (102025000021085) - 8/8/2025
- *Vibrometro a tracciamento di speckle ad elevato guadagno* (102025000021097) - 8/8/2025