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Chapter 1 : Principles and Practice of Laser-Doppler Anemometry | Journal of Applied Mechanics | ASME I

Another application name is laser Doppler anemometry LDA. A variety of similar instruments were developed for solid-surface monitoring, with applications ranging from measuring product speeds in production lines of paper and steel mills, to measuring vibration frequency and amplitude of surfaces. The two beams are usually obtained by splitting a single beam, thus ensuring coherence between the two. Lasers with wavelengths in the visible spectrum nm are commonly used; these are typically He-Ne, Argon ion , or laser diode , allowing the beam path to be observed. A transmitting optics focuses the beams to intersect at their waists the focal point of a laser beam , where they interfere and generate a set of straight fringes. As particles either naturally occurring or induced entrained in the fluid pass through the fringes, they reflect light that is then collected by a receiving optics and focused on a photodetector typically an avalanche photodiode. The reflected light fluctuates in intensity, the frequency of which is equivalent to the Doppler shift between the incident and scattered light, and is thus proportional to the component of particle velocity which lies in the plane of two laser beams. If the sensor is aligned to the flow such that the fringes are perpendicular to the flow direction, the electrical signal from the photodetector will then be proportional to the full particle velocity. By combining three devices e. The sensor also splits the laser beam into two parts; one the measurement beam is focused into the flow and the second the reference beam passes outside the flow. A receiving optics provides a path that intersects the measurement beam, forming a small volume. Particles passing through this volume will scatter light from the measurement beam with a Doppler shift; a portion of this light is collected by the receiving optics and transferred to the photodetector. The reference beam is also sent to the photodetector where optical heterodyne detection produces an electrical signal proportional to the Doppler shift, by which the particle velocity component perpendicular to the plane of the beams can be determined. Applications In the decades since the LDV was first introduced, there has been a wide variety of laser Doppler sensors developed and applied. Flow Research Laser Doppler velocimetry is often chosen over other forms of flow measurement because the equipment can be outside of the flow being measured and therefore has no effect on the flow. Some typical applications include the following: Wind tunnel velocity experiments for testing aerodynamics of aircraft, missiles, cars, trucks, trains, and buildings and other structures Velocity measurements in water flows research in general hydrodynamics, ship hull design, rotating machinery, pipe flows, channel flow, etc. Fuel injection and spray research where there is a need to measure velocities inside engines or through nozzles Environmental research combustion research, wave dynamics, coastal engineering, tidal modeling, river hydrology, etc. This distance restriction has recently been at least partially overcome with a new sensor that is range independent. Within the clinical environment, the technology is often referred to as laser Doppler flowmetry LDF. The beam from a low-power laser usually a laser diode penetrates the skin sufficiently to be scattered with a Doppler shift by the red blood cells and return to be concentrated on a detector. These measurements are useful to monitor the effect of exercise, drug treatments, environmental, or physical manipulations on targeted micro-sized vascular areas. It also has potential use in the operating room to perform measurements of prosthesis and stapes stirrup displacement.

Chapter 2 : Laser Doppler velocimetry - Wikipedia

Abstract This book deals with the measurement of instantaneous velocity by laser Doppler methods. A historical review of laser Doppler anemometry is given, its relationship to other optical techniques is examined, and principles of geometrical, physical, and quantum optics are outlined.

Technology origin[edit] With the development of the heliumâ€"neon laser He-Ne at the Bell Telephone Laboratories in , the optics community had available a source of continuous wave electromagnetic radiation highly concentrated at a wavelength of Another application name is laser Doppler anemometry LDA. A variety of similar instruments were developed for solid-surface monitoring, with applications ranging from measuring product speeds in production lines of paper and steel mills, to measuring vibration frequency and amplitude of surfaces. In its simplest and most presently used form, LDV crosses two beams of collimated , monochromatic , and coherent laser light in the flow of the fluid being measured. The two beams are usually obtained by splitting a single beam, thus ensuring coherence between the two. A transmitting optics focuses the beams to intersect at their waists the focal point of a laser beam , where they interfere and generate a set of straight fringes. As particles either naturally occurring or induced entrained in the fluid pass through the fringes, they reflect light that is then collected by a receiving optics and focused on a photodetector typically an avalanche photodiode. The reflected light fluctuates in intensity, the frequency of which is equivalent to the Doppler shift between the incident and scattered light, and is thus proportional to the component of particle velocity which lies in the plane of two laser beams. If the sensor is aligned to the flow such that the fringes are perpendicular to the flow direction, the electrical signal from the photodetector will then be proportional to the full particle velocity. By combining three devices e. The sensor also splits the laser beam into two parts; one the measurement beam is focused into the flow and the second the reference beam passes outside the flow. A receiving optics provides a path that intersects the measurement beam, forming a small volume. Particles passing through this volume will scatter light from the measurement beam with a Doppler shift; a portion of this light is collected by the receiving optics and transferred to the photodetector. The reference beam is also sent to the photodetector where optical heterodyne detection produces an electrical signal proportional to the Doppler shift, by which the particle velocity component perpendicular to the plane of the beams can be determined. Applications[edit] In the decades since the LDV was first introduced, there has been a wide variety of laser Doppler sensors developed and applied. Flow research[edit] Laser Doppler velocimetry is often chosen over other forms of flow measurement because the equipment can be outside of the flow being measured and therefore has no effect on the flow. Some typical applications include the following: Wind tunnel velocity experiments for testing aerodynamics of aircraft, missiles, cars, trucks, trains, and buildings and other structures Velocity measurements in water flows research in general hydrodynamics, ship hull design, rotating machinery, pipe flows, channel flow, etc. Fuel injection and spray research where there is a need to measure velocities inside engines or through nozzles Environmental research combustion research, wave dynamics, coastal engineering , tidal modeling, river hydrology, etc. This distance restriction has recently been at least partially overcome with a new sensor that is range independent. It can also be used to measure the speed of solid objects, like conveyor belts. This can be useful in situations where attaching a rotary encoder or a different mechanical speed measurement device to the conveyor belt is impossible or impractical. Medical applications[edit] Laser Doppler velocimetry is used in hemodynamics research as a technique to partially quantify blood flow in human tissues such as skin. Within the clinical environment, the technology is often referred to as laser Doppler flowmetry LDF. The beam from a low-power laser usually a laser diode penetrates the skin sufficiently to be scattered with a Doppler shift by the red blood cells and return to be concentrated on a detector. These measurements are useful to monitor the effect of exercise, drug treatments, environmental, or physical manipulations on targeted micro-sized vascular areas. It also has potential use in the operating room to perform measurements of prosthesis and stapes stirrup displacement.

Chapter 3 : Laser Doppler Anemometry

Comment: A readable copy. All pages are intact, and the cover is intact. Pages can include considerable notes-in pen or highlighter-but the notes cannot obscure the text.

Laser Doppler velocimetry Save Laser Doppler velocimetry LDV , also known as laser Doppler anemometry LDA , is the technique of using the Doppler shift in a laser beam to measure the velocity in transparent or semi-transparent fluid flows, or the linear or vibratory motion of opaque, reflecting, surfaces. The measurement with LDA is absolute, linear with velocity and requires no pre-calibration. Technology origin With the development of the heliumâ€"neon laser He-Ne at the Bell Telephone Laboratories in , the optics community had available a source of continuous wave electromagnetic radiation highly concentrated at a wavelength of Another application name is laser Doppler anemometry LDA. A variety of similar instruments were developed for solid-surface monitoring, with applications ranging from measuring product speeds in production lines of paper and steel mills, to measuring vibration frequency and amplitude of surfaces. In its simplest and most presently used form, LDV crosses two beams of collimated , monochromatic , and coherent laser light in the flow of the fluid being measured. The two beams are usually obtained by splitting a single beam, thus ensuring coherence between the two. A transmitting optics focuses the beams to intersect at their waists the focal point of a laser beam , where they interfere and generate a set of straight fringes. As particles either naturally occurring or induced entrained in the fluid pass through the fringes, they reflect light that is then collected by a receiving optics and focused on a photodetector typically an avalanche photodiode. The reflected light fluctuates in intensity, the frequency of which is equivalent to the Doppler shift between the incident and scattered light, and is thus proportional to the component of particle velocity which lies in the plane of two laser beams. If the sensor is aligned to the flow such that the fringes are perpendicular to the flow direction, the electrical signal from the photodetector will then be proportional to the full particle velocity. By combining three devices e. The sensor also splits the laser beam into two parts; one the measurement beam is focused into the flow and the second the reference beam passes outside the flow. A receiving optics provides a path that intersects the measurement beam, forming a small volume. Particles passing through this volume will scatter light from the measurement beam with a Doppler shift; a portion of this light is collected by the receiving optics and transferred to the photodetector. The reference beam is also sent to the photodetector where optical heterodyne detection produces an electrical signal proportional to the Doppler shift, by which the particle velocity component perpendicular to the plane of the beams can be determined. Applications In the decades since the LDV was first introduced, there has been a wide variety of laser Doppler sensors developed and applied. Flow research Laser Doppler velocimetry is often chosen over other forms of flow measurement because the equipment can be outside of the flow being measured and therefore has no effect on the flow. Some typical applications include the following: Wind tunnel velocity experiments for testing aerodynamics of aircraft, missiles, cars, trucks, trains, and buildings and other structures Velocity measurements in water flows research in general hydrodynamics, ship hull design, rotating machinery, pipe flows, channel flow, etc. Fuel injection and spray research where there is a need to measure velocities inside engines or through nozzles Environmental research combustion research, wave dynamics, coastal engineering , tidal modeling, river hydrology, etc. This distance restriction has recently been at least partially overcome with a new sensor that is range independent. It can also be used to measure the speed of solid objects, like conveyor belts. This can be useful in situations where attaching a rotary encoder or a different mechanical speed measurement device to the conveyor belt is impossible or impractical. Medical applications Laser Doppler velocimetry is used in hemodynamics research as a technique to partially quantify blood flow in human tissues such as skin. Within the clinical environment, the technology is often referred to as laser Doppler flowmetry LDF. The beam from a low-power laser usually a laser diode penetrates the skin sufficiently to be scattered with a Doppler shift by the red blood cells and return to be concentrated on a detector. These measurements are useful to monitor the effect of exercise, drug treatments, environmental, or physical manipulations on targeted micro-sized vascular areas. It also has potential use in the operating room to perform measurements of prosthesis and stapes stirrup displacement.

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