

Focus on BGIA's work

Institut für Arbeitsschutz der Deutschen Gesetzlichen Unfallversicherung

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System for the three-dimensional measurement of hand forces

Problem

In many areas of research and industry, a need exists for hand forces to be measured: for the assessment of mechanical stresses upon the body in the area of ergonomics; in order to record and test the operation of machinery or equipment; and for a range of technical design tasks. Hand forces occur for example during the pushing, pulling, lifting or carrying of loads, specifically during the pushing of trolleys of all kinds, or during the opening and closing of a protective door on a lathe. A suitable hand force measurement system should permit both short-term and long-term measurements and be suitable for use in both the field and the laboratory.

Activities

The BGIA has developed a measurement system for the separate recording of hand forces in three dimensions. It can be employed very flexibly in the area of development or research under both field and laboratory conditions, during the testing of hand forces in the area of controls, and also during the measurement and adjustment of hand forces on human-machine interfaces. The hand forces can be recorded continuously over both the short and long term, for example over an entire working shift.

Two separate hand force measurement handles are used to record a subject's hand forces, as shown in the figure. The inner handles are coupled at each end to the rigid enclosure by three-axis force transducers. The three-axis hand forces and the points of application of the force are calculated from the individual force components of the sensors and the enclosure geometry.



Left-hand and right-hand handle with data logger

The figure shows the measurement system in logger mode. The measurement signals are stored temporarily in this case in a portable recording unit. For static measurements, the hand forces can also be recorded by means of an online link between the hand force measurement handles and a PC.

The measurement signals can then be displayed and processed further by means of a dedicated software application. Processing includes analyses and visualization of the discrete force components, the overall forces, and the points of force application on the handles. The internal co-ordinate system of the handles, a co-ordinate system on the object concerned, or the spatial co-ordinate system can be selected for analysis and display of the signals. All measured and analysed signals of the forces and force application points can be exported in common file formats for further use.

Results and Application

The hand force measurement system has a wide range of uses in occupational safety and health: in preventive activity, for the identification of work-related health hazards; retrospectively, during investigations of occupational diseases, which may have been caused in the course of a working life as a result of high load handling; or very generally in ergonomic and biomechanical load analyses.

The hand force measurement system comprises a complete system. The user requires only a computer with an up-to-date specification. The system includes the basic technical equipment required for adaptation to the objects under examination. Depending upon the application, special technical adaptations must be made by the user. Owing to the readily accessible ports, the handles can easily be integrated into other measurement applications.

Area of Application

Research organizations studying ergonomic and biomechanical problems; businesses or organizations performing test or design tasks in the human-machine interface

Additional Information

- The hand force measurement system developed at the BGIA is manufactured and distributed under licence by KISTLER Instrumente AG, Postfach, 8408 Winthertur, Switzerland.

Expert Assistance:

BGIA, Division 5: Accident prevention – Product safety

BGIA, Central Division: Interdisciplinary services

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