Fraunhofer IBP

FRAUNHOFER INSTITUTE FOR BUILDING PHYSICS IBP

DressMAN 2.0

Indoor environments, like rooms, cabins or passenger areas, can show inhomogeneous and transient thermal conditions. For instance, when leaving a car parked in the sun the interior temperature would rise to uncomfortable degrees. Seeking to understand complex thermal boundary conditions and to assess them objectively in such cases requires an appropriate measurement principle. Until now, an assessment of thermal comfort inside car cabins was performed by measuring individual aspects of the interior climate such as air temperature, where the aquired data was used to rate the efficacy of vehicle climate control systems. This ignores the fact that individual parameters may compensate for each other. Being exposed to cold airflow and bright sun at the same time is one example, where common approaches fail to predict human thermal sensation properly. The following parameters are relevant when considering heat transfer between the human body and its surroundings in dry conditions:

– Air temperature
– Mean air velocity
– Mean radiant temperature of the enclosing surfaces
– Direct and diffuse solar radiation

The Fraunhofer Institute for Building Physics IBP has used the first generation of DressMAN for many years. The system helps to assess the thermal environmental conditions inside buildings, cars and planes. An automotive research project funded by Germany's Federal Ministry of Education and Research (BMBF) allowed for a full redesign and enhancement of the climate-measuring system, now called DressMAN 2.0.

Fraunhofer Institute for Building Physics IBP

Holzkirchen site
Fraunhoferstrasse 10
83626 Valley
Germany

Contact
Dipl.-Inf. Sebastian Stratbücker
Phone +49 8024 643-632
Fax +49 8024 643-366
sebastian.stratbuecker@ibp.fraunhofer.de

www.ibp.fraunhofer.de

System concept

The new system concept relies even more on the use of commercially available components, while software is developed exclusively within the institute. A new comfort sensor was also developed, which enables researchers to measure what is known as the equivalent temperature. This thermal comfort index, defined in ISO 14505-2, incorporates measurements of air temperature, air velocity and thermal radiation. Thus thermal environmental conditions are summarised and quantified, enabling different climate scenarios to be compared and evaluated.

Equivalent temperature sensor

The sensor records the heat dissipated by a measuring element, which must be heated to a defined temperature, as well as the surface temperature of the element itself. These measurements are then used to determine the equivalent temperature. A variety of sensors to measure quantities such as air temperature or air velocity can be integrated into the new DressMAN 2.0 system. In that way local impact factors to thermal sensation can be separately monitored at specific body parts. The DressMAN system integrates a maximum of 16 equivalent temperature sensors, which are usually attached to a human dummy. Each sensor can be placed indiviually across the entire body in a position that best suits the intended measuring task.

System software

The system software of DressMAN 2.0 was developed at Fraunhofer IBP. The software takes local equivalent temperatures as they are recorded and interprets the data in relation to thermal sensation, allowing the software to evaluate the comfort level in each case. ISO 14505-2 provides information about local comfort zones which were determined for application in vehicles. The data is based on equivalent temperatures taken for various parts of the human body under both summer and winter conditions, which were then correlated with subjects questionnaire responses regarding local thermal comfort. DressMAN 2.0 already provides the required interfaces which are needed to correlate measurements using an appropriate comfort model. The recorded data is logged and displayed while measurement continues in the form of a table, a chart showing changes over time or a color-coded virtual manikin.

The "IBP Sensor Interface" is thereby providing the necessary functions for sensor control and data acquisition. The application is also responsible for governing the heat of the equivalent temperature sensors. It collates measurement data into tables and shows variations over time, displaying the measurement values and offering a network interface to control and query data externally.

In order to be able to derive a defined equivalent temperature from the measurement values, the program must actively regulate the thermal setpoint of the sensors. There are two different modes to choose from: either constant surface temperature or constant heat flux through the surface of the sensor.

Application

DressMAN 2.0 is currently being used by the partners of the E-Komfort project, where it is tested in climate chamber in order to evaluate innovative climatisation concepts for electric cars. Since this is an area where the focus is on localized heating and cooling devices, Fraunhofer IBP's new measuring system offers the ideal platform for assessing inhomogeneous and transient load cases which will challenge future electric vehicles. The measuring system can also be employed in various areas of the aerospace sector. Whether in the plane cabin or in the cockpit, DressMAN helps to ensure thermal comfort of passengers and crew members. Since DressMAN 2.0 is specifically designed for varying and intricate indoor thermal environments, it is also suitable for assessing draft risk or asymmetric thermal radiation, for example caused by cold surfaces. These problems do not only occur in the transport sector but may also impair human thermal comfort in present-day office buildings or industrial work places.