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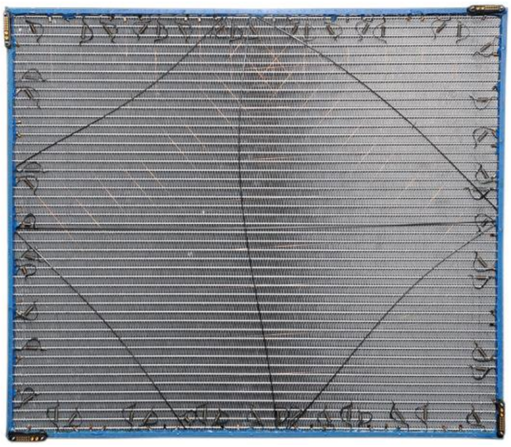
MCCA - MULTI CONSTANT CURRENT ANEMOMETRY

The MCCA is a revolutionary flowmeter – its negligible invasiveness, high insensitivity to velocity and temperature fields and ease of use make it an ideal (and often the only possible) choice for the applications of vehicle cooling, white goods or power engineering. The sensor was tested in the harsh conditions of automotive cooling and is able to withstand temperatures of up to 125°C. Supplied software package make it as easy to use as possible.



FEATURES

Airflow rate measurement: The MCCA measures airflow rate with accuracy better than +-5% under usual operating conditions. The airflow rate is obtained by integrating the velocity field, see Figure 1. The overall error is strongly insensitive to the shape of the velocity field, furthermore a preview of velocity field is available. Care should be taken when interpreting the velocity field since local velocity accuracy is not guaranteed.

Heat flux measurement: Heat flux can be calculated from known velocity and temperature field. The MCCA is capable of measuring average temperature within +-1°C. The overall mean temperature error is strongly insensitive to the shape of the temperature field, preview of temperature field is given besides the average value (see Figure 2.) Care should be taken when interpreting the preview since local temperature accuracy is not guaranteed.

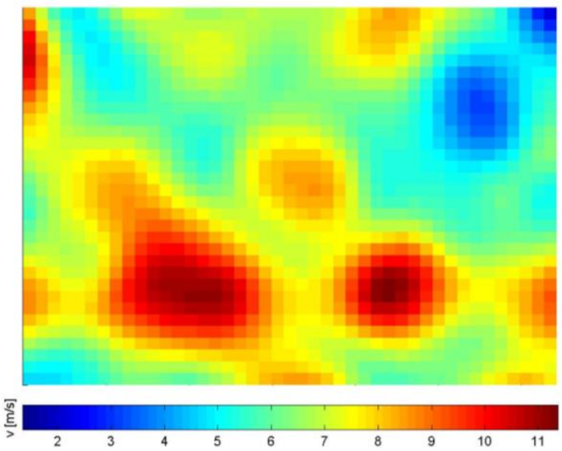


Figure 1: MCCA outputs a preview of velocity field

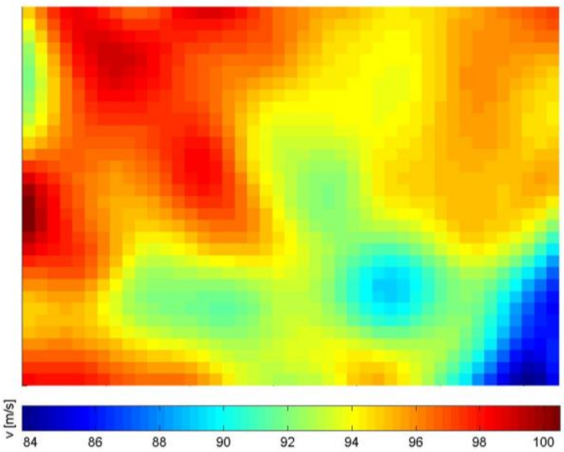


Figure 2: MCCA outputs a preview of temperature field

PRINCIPLE

Measurement principle: The MCCA uses a regular net of wires. The wires are not connected in their intersections and only integral values of electrical properties are known. The wires are either heated by constant current to measure velocity or not heated at all and measure temperature. The latter can be understood as an RTD temperature measurement. The resistance of the wire in both modes is calibrated in a homogenous velocity and temperature field against both velocity and temperature. The principle is covered by a patent.

Evaluation: An inverse problem is formulated and solved by an iterative algorithm that finds such a distribution of the scalar quantity (be it velocity or temperature) which satisfies the measured values. The solution converges very reliably in a few iteration steps. The implementation of the algorithm is optimized so that the user gets an instantaneous solution within less than a second.

Restrictions: There is a principal restriction to the operation of the MCCA which resides in velocity to airflow rate interpretation.

Imagine a scenario as sketched in Figure 3: air is flowing through a honeycomb and is deflected by an obstacle. The velocity that the wires measure is the magnitude] *v* while what is important for the airflow rate measurement is velocity v_x. This is not an issue when using MCCA behind radiators with heat exchanging area such that straightens the flow. A honeycomb is suggested in other applications where perpendicularity of the flow might not be fulfilled.

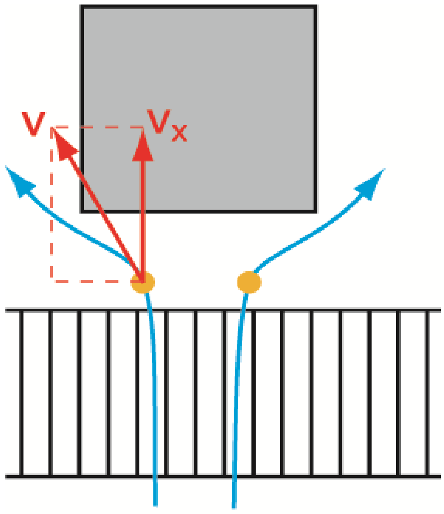


Figure 3: Flow needs to be perpandicular to the control plane

PROPERTIES

Dynamic properties: The MCCA was intended for measurement of stationary phenomena only. The sensor takes approximately 400ms per wire to perform the measurement, which is around 25 seconds for a 600 x 450 mm sensor with a usual net density. Wires are sampled in a one-by-one manner and so both velocity and temperature fields need to be stabilized during the sampling process for the sensor to operate correctly.

Mechanical properties: The rim of the MCCA sensor is only 5 x 9 mm and is carefully designed to be as little invasive as possible, see Figure 4. The minimum achievable dimensions are approximately 150 x 150 mm and maximum achievable dimensions are 550 x 750 mm.

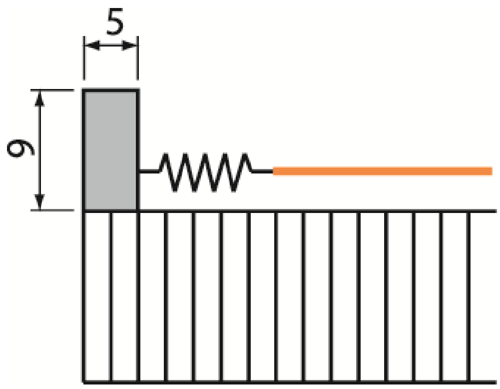


Figure 4: Rim of the sensor is only 5x9mm

ACCURACY

The accuracy is guaranteed for usual working condition. While this formulation does not give a potential user much of an idea one needs to keep in mind that there are many dimensions to the problem. Of special interest is the insensitivity of the reading to the shape of the scalar fields – the sensor covers a very wide range of distributions but is only capable of capturing those gradients that are considerably smaller dimension-wise than the distance between two neighboring wires. The particular limit of the shape of the scalar fields when accuracy is not met anymore needs to be tested for the particular application and shall be consulted with 4Jtech s.r.o.

MCCA SPECIFICATIONS	
MEASUREMENT RANGE	
Airflow rate	0-15 m/s locally
Temperature	15°C to 125°C locally
ACCURACY	
Airflow rate	<5% for v_{avg}>0.2m/s
Average temperature	+-1°C
DIMENSIONS	
Rim size	5 x 9 mm
Minimum dimensions	150 x 150 mm
Maximum dimensions	550 x 750 mm
OPERATING RANGE	
Temperature - unlimited time	105°C
Temperature short term	125°C
ABSOLUTE MAXIMUM RATINGS	
Storage temperature	-40°C to 140°C
Operating temperature	-40°C to 140°C

APPLICATION

Fields of application: The MCCA is an extremely powerful tool for airflow and heat flux measurement wherever

1. Velocity and/or temperature field is non-homogenous
2. Installation space is limited
3. Low velocities capability is needed
4. High temperature operation is needed

A wide range of applications of internal aerodynamics and heat transfer can benefit from MCCA including automotive cooling air measurement, HVAC, measurements in white goods (tumble driers, vacuum cleaners, …). There are also many applications in the field of power engineering – generally external flow of heat exchangers such as direct condensers and so on.

Environment: The sensor was primarily developed for automobile cooling air measurement. The construction is capable of withstanding the extremely harsh environment of the engine compartment that combines both strong vibrations and high temperature. The sensor can be operated both in laboratory environment and during in vivo testing when battery powered.

Working fluid: The sensor is normally operated in air. Water version was successfully tested and may be delivered upon request.

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MEASUREMENT SYSTEM

Hardware connection: The MCCA connects to a Central Unit (CU, Figure 6) via a single cable up to 5m in length. The CU power input is 12V DC and can therefore be powered by either a 110/230V adapter or by a 12V battery. Connection to PC is made through the ETHERNET interface.

Figure 5: Central Unit for data readout with an ETHERNET interface

Software User Interface: A Graphical User Interface is supplied with the sensor. The sotfware is made as simple for the user as possible – the MCCA is a Plug-and-Play device which stores all of its information inside of the rim – such as geometry data, calibration, setup, ... This makes it easier for the user to keep track of calibrations and actual setup of the sensor.

Postprocessing: The GUI displays an instantenous preview of velocity field and flow rate after each measurement is finished. Additional postprocessing may be done in a set of postprocessing tools in Matlab. The user is responsible for the licensing.

Compatibility: The CU and GUI are compatible with other sensors from our portfolio such as the pressure strips or the RPM meter.

CONTACT

Please, contact 4Jtech, s.r.o. for more information. We will be happy to answer any of your questions.

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DOCUMENT REVISION HISTORY

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