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# Magnetic Multimedia Interface

Magnetic position and orientation detection systems have recently found their way into industrial applications due to newly developed magnetic sensor technologies. In this project, a novel magnetic map has led to the development of a 4-axis multimedia control element based on magnetic sensors thus replacing state-of-the-art systems based on three optical encoders, light guides and touch buttons. The map was successfully tested, improved and integrated into a mass demonstrator aiming for a highly functional future prototype.

## Background: Magnetic Position and Orientation Detection

A magnetic position and orientation detection system determines the position and/or orientation of an object that moves relative to a magnetic sensor. A permanent magnet is fixed to the object so that it's motion results in a variation of the magnetic field at the sensor. Such systems can be realized in various ways and find multiple applications in modern industries, e.g. to detect suspended axles, in the detection of shifting shafts, for automotive gear shifts, flexible arm mechanisms, dump trailers, lift systems and generally wherever there is the need to detect a motion in the range of a few centimeters.

For high precision measurement in harsh environments the implementation based on magnetic sensors has proven to be an excellent, cost effective solution. The advantages include high resolutions, low power requirements, contact-free measurement, a potential for miniaturization and an excellent robustness against temperature and dirt without the need of airtight seals or other extreme environmental contamination control.

As the magnetic field easily penetrates materials like dirt, oil or grease such systems are ideal for application in motors and machinery. Additionally, the production cost of modern magnets is low and their lifetime is estimated to be of several decades if treated with care. The advent of industrial fabrication of cost-efficient 3D-Hall sensor technology has opened many new possibilities for the design and construction of advanced magnetic position and orientation systems.

## Development and Verification of a 4-axis Control Element

In this project a 4-dimensional multimedia control element was developed. Similar to a BMW iDrive, the element features a rotation, two tilt directions and a push button option. While the

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iDrive includes three optical encoders, a complex light guide system and a push button sensor, the developed control element should detect the entire motion spectrum with just a single magnetic sensor, aiming to reduce costs while improving stability and precision.

The design of a magnetic map that realizes the full range of the desired motion of an application is often not an easy task due to ferromagnetic surroundings and the highly non-linear character of the magnetic field of a permanent magnet.

Mathematical solutions developed at CTR for the implementation and optimization of magnetic maps were used to determine the field distribution and ideally position the sensors. The mathematical model was successfully verified by extensive FEM simulation, see Figure 1 and additional experiments.

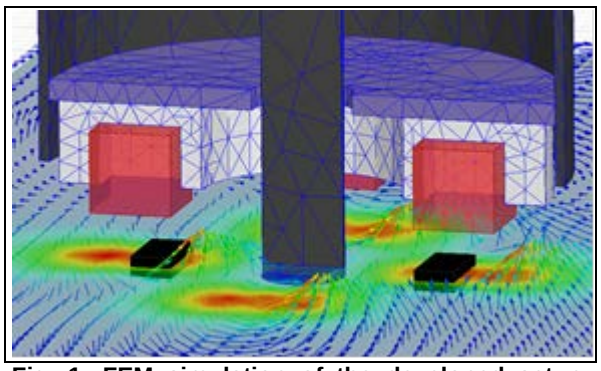

**Fig. 1: FEM simulation of the developed setup. The magnets (red) are incorporated into the control element so that all four types of motion can be detected by the sensors below.**

## Impacts and perspectives

The development of this new magnetic map was the basis for the construction of a prototype. In a first step the developed system was integrated into the chassis of a BMW iDrive to demonstrate the principle. To that end, all sensor and control elements of the iDrive were replaced by the much simpler magnetic setup. The magnetic sensors can be read out via USB to connect to a graphical representation of the mechanical states on the PC for presentation purposes. In the second step the original chassis was modified for show effects to yield the optically appealing mass demonstrator depicted in Figure 2.

**Fig. 2: Final version of the mass demonstrator by integration of the developed magnetic system into a BMW iDrive chassis.**

The prototype demonstrates successfully that the magnetic solution can be used to replace more difficult and complex implementations of position and orientation detection systems which is of great interest for industrial partners. Based on the above development a new magnetic map is designed for further cost-reduction by featuring on a single magnet and a single sensor.


**Contact and information**

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