Racing car with electric drive

April 26 2013

The racing car from the e-racing team at Hochschule Esslingen University of Applied Sciences speeds round the track without a sound, powered by an electric engine. © E-Rennstall, Hochschule Esslingen

Drive technology has an electric future – of this Fraunhofer research scientists are in no doubt. At the Sensor + Test measurement fair in Nuremberg from May 14 -16, they will use an electric racing car to present novel solutions for battery management and electronic sensor systems together with an industry partner. The scientists are right on trend, as even FIA, the governing body for world motor sport, federation

of the world's leading motoring organizations and organizer of Formula 1, is planning a racing series for electric vehicles.

From 0 to 100 in 3.6 seconds – we're not talking about the rapid acceleration of a Porsche Carrera or Ferrari Scaglietti, but of EVE, a racing car with a very quiet engine. EVE is powered by two electric motors, one for each rear wheel. With a maximum output of 60 kilowatts, they get the e-racer going at 4500 rotations per minute. The sprinter can reach a top speed of 140 km/h, and has a range of 22 km thanks to two lithium polymer batteries, with a combined capacity of 8 kWh. Electrical engineering students from the e-racing team at the Hochschule Esslingen University of Applied Sciences designed the 300 kg car as a voluntary project alongside their studies, and they have already competed in it at the international Formula Student Electric (FSE) race in Italy. From May 14-16, the racing car will be on show at the Sensor + Test measurement fair in Nuremberg at the joint Fraunhofer trade show booth (Hall 12, Booth 537). Scientists from the Fraunhofer Institute for Integrated Circuits IIS in Erlangen developed the entire electronic sensor system in close collaboration with Seuffer GmbH & Co.KG, an industry partner with whom the institute has been working for over 11 years. Seuffer GmbH & Co.KG is based in Calw in Baden-Württemberg, southern Germany, and sponsors the students of the E.Stall racing team.

"Electromobility as a topic is becoming ever more important. The racing car serves as a showcase for us to demonstrate novel sensor solutions as well as battery and energy management concepts," says Klaus-Dieter Taschka, an engineer at Fraunhofer IIS. Besides wheels, brakes, damper unit, batteries and electric motors, EVE is equipped with numerous sensors. These include braking pressure, crash, temperature and acce-

leration sensors as well as sensors that monitor the accelerator and brake pedals, speed, steering angle, wheel speed and power. These last six

functions could all be performed by HallinOne® sensors developed by Fraunhofer IIS, 3D magnetic-field sensors that are already a standard feature in washing machines, where they are used to determine the position and orientation of the drum.

Electronic sensors determine charge state of the battery

The two electronic sensors attached at the sides of the batteries use 3D magnetic-field sensor technology developed by Fraunhofer IIS to measure the magnetic field generated by the flow of electrical current and thus to determine the battery's level of charge. What's special about this is that the contactless sensors measure both the current that flows from the battery to the engine and the current that flows back again when the vehicle brakes. The integrated sensor system is able to eliminate disturbances and foreign magnetic fields, thus guaranteeing very precise measurements. A further advantage is that the system is also able to measure other aspects of the battery such as its voltage and temperature. The data is collected and sent to the power control unit (PCU) and the battery management system (BMS), which controls the charging and discharging processes.

Intelligent battery management system extends battery life

Battery running times and battery life are limiting factors for all electric vehicles. The BMS developed by Fraunhofer IIS in Nuremberg tackles this problem by determining the impedance spectrum of all battery cells and constantly testing whether the cells are functioning properly. This allows cells' condition, current capacity and potential service life to be ascertained and running times to be predicted more accurately.

As individual battery cells age, they are able to store less and less energy. The challenge lies in optimizing cell utilization. "Until now, a battery system was able to provide only as much energy as was available in its weakest cell. The energy stored in other cells remained unused. Our BMS has an active cell balancing system that moves energy between stronger and weaker cells. This means that all cells share the load equally, allowing the maximum capacity of the battery as a whole to be utilized," explains Dr.-Ing. Peter Spies, group manager at Fraunhofer IIS in Nuremberg. Actively balancing out the cells during the charging and discharging process extends the battery's service life and range. "EVE's current BMS is a system developed in house by E.Stall, but our solution could take its place," says Spies.

Polarization camera detects cracks in bodywork

EVE's compact design is built on a tubular steel space frame housed within a carbon fiber body. Racing around the track puts a great deal of stress on the plastic fibers, and this can lead to tiny cracks developing in the material. Fraunhofer IIS in Erlangen has developed POLKA, a polarization camera that can detect such damage at an early stage by measuring stresses within unpainted surfaces of the carbon structure. This compact camera makes any scratches visible by registering properties of light that are imperceptible to the human eye: polarization. Material stresses in the plastic cause changes in polarization. POLKA is able to collect all the polarization information for each pixel in a single shot at speeds of up to 250 frames per second. Using real-time color coding, the dedicated software translates the information collected about the intensity, angle and degree of polarization into a visual display that is accessible to the human eye. The system will also be presented at the joint Fraunhofer booth.

"We are convinced that EVE's innovative technology will allow the vehicle to perform very well while demonstrating excellent

environmental awareness," says Rolf Kleiner, group manager of the battery technology department at Seuffer. And the students of team E.Stall will soon have a chance to prove it: This year EVE will be in the lineup for the Formula Student race in Italy, Spain and Czechia.

Provided by Fraunhofer-Gesellschaft