



## **EMBEDDED SENSING AND ACTUATION FOR HELMETS CO2 LEVELS CONTROL**

John Kemp<sup>1</sup>, Elena Gaura<sup>1</sup>, James Brusey<sup>1</sup>, Doug Thake<sup>2</sup>

<sup>1</sup>Cogent Computing ARC, Faculty of Engineering and Computing, Coventry University, UK

<sup>2</sup>Faculty of Health and Life Sciences, Coventry University, UK

Email: {aa9384, e.gaura, j.brusey, apx223}@coventry.ac.uk

---

*Submitted: January 15, 2010   Accepted: February 17, 2011   Published: March 1, 2011*

---

**Abstract-** The paper reports on the development and evaluation of a simple closed loop solution for controlling the CO<sub>2</sub> levels within small enclosed environments, such as Explosive Ordnance Disposal (EOD) protective suit helmets. Based on a detailed analysis of the helmet environment during bomb disposal missions, the solution proposed automates the current manually controlled fan integrated within the helmet to achieve an effective, timely and energy efficient, control system.

Whilst the paper and its supporting experimental work focus on the particular case study of operatives wearing EOD suit helmets, the methods proposed and the control system development methodology are generic and directly applicable to a wide class of helmet usage scenarios.

The main contributions in the paper are as follows: i) the design and implementation of an empirical helmet model based on data collected with a bespoke helmet embedded instrument developed by the authors; and ii) the production of a simple but effective fan air flow control algorithm for containing CO<sub>2</sub> concentration exposure during missions, and an associated evaluation simulator/test bed. The resulting closed loop, automated sensing and actuation system extends the otherwise short fan battery lifetime to cover entire missions, delivers a healthy breathing environment for the operative and minimises noise disruption associated with the use of the fan. The control algorithm outperforms fixed airflow settings in terms of energy efficiency.