**University of Leicester**

**College of Life Sciences /College of Science and Engineering**

**HPRU Grant studentship**

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**Section 2 – *Project Information***

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| **Project Title** | Development of multi-modality learning techniques for early chemical anomaly detection |
| **Project Summary** | |
| Breathomics has recently become a popular research area, where tiny chemical molecules in the air that people breathe out can be measured and quantified. These molecules can be considered as fingerprints of what happens inside the human body or in the environment. By analysing the changes in our breath, breathomics can help us to predict human diseases or environmental changes early, and convince healthcare or governmental agencies to deploy early intervention to prevent the occurrence of worse scenarios. This project will characterise what ‘normal’ breath is like, including for those with common conditions, which allows exposures to threats/hazards to be detected as anomalies in breath.  Researchers have used volatile organic compounds (VOCs) in human exhalation to measure human health states and/or environmental changes. Technological progress such as time of flight spectrometry have been used to deliver non-invasive diagnosis. Mass spectrometry technology further advances the field by detecting minute chemical traces in a large data pool. On the other hand, artificial intelligence/machine learning technologies have been deployed to discover potential biomarkers, using Principal Component Analysis and Random Forest. PCR tests and cell culture studies have been used to validate these findings. In recent years, deep learning approaches have been established to render large datasets, however, they have not explored much the application of multi-modality analysis in early detection of biomarkers for chemical hazard and risk assessment.  AIDAM is an AI research centre at University of Leicester, co-led by Prof Huiyu Zhou. AIDAM comprises a critical mass in the development of novel AI/ML algorithms and tools, with applications in medical sciences and earth observation. In partnership with the Health and Safety Executive and the UK Health Security Agency, this project intends to develop novel AI technologies to early detect chemical hazard and exposure. In particular, this proposed project, using chemical sensors designed by the University of Leicester, existing image collection systems at UKHSA and broadcasting weather data, will target at increment of accuracy and precision (over 10% ↑) against that of traditional AI solutions over standard datasets.  Benefits and impacts –  Our proposed project will offer a non-invasive and rapid sequencing tool for early quantifying chemical hazard in an early stage. This allows humans to avoid dangerous environments and hence improve their health states. Our proposed project aims to combine technological developments of data science and chemical engineering, widening and deepening multi-disciplinary technological development in the field. The proposed research has the potential to be extended to human diseases and drug discovery.  The student will benefit from training at the University of Leicester and the UK Health Security Agency in this collaborative project. The student will receive training in data sciences and chemical engineering courses, such as sensor information and computational intelligence.  Working in different units will allow the student to pursue a multi-disciplinary solution to tackle the challenging chemical sensing problem. The student, upon successful study, will be able to deal with different issues in research with much confidence.  The National Institute for Health and Care Research (NIHR) Health Protection Research Unit (HPRU) in Chemical Threats and Hazards is based at the University of Leicester and is a partnership between the University, the UK Health Security Agency (UKHSA) and the Health and Safety Executive (HSE). As part of the HPRU, students will benefit from co-supervision and placements at least one of UKHSA or HSE. The HPRU in Chemical Threats and Hazards is dedicated to career development, and all students will receive tailored training and will be engaged with Patient and Public Involvement (PPI) and Research Inclusion. | |