Miniature, ultra-light and sensitive personal radiation monitoring system for the Australian Defence Force

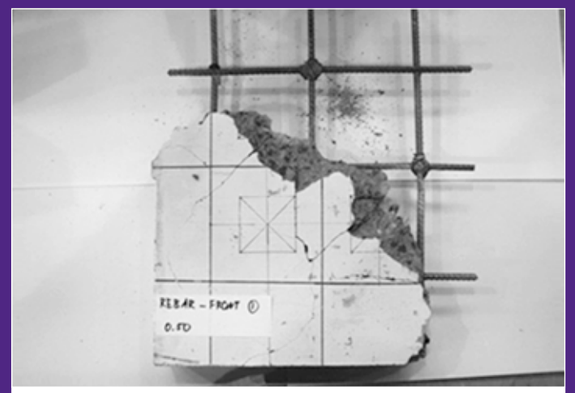
Prof Hans Riesen

We have designed, implement and specified a mobile-phone-size personal radiation monitoring system, with a resolution of 20 µGy surface dose, for the Australian Defence Force. Deployed ADF personnel have a significant risk of being exposed to ionizing radiation sources such as 'dirty bombs'. The system enables rigorous monitoring of exposure and hence risk management and reduction. The present project built on developments funded by an Australian Research Council (ARC) Discovery Project (2007-2009) and a Defence-related Research (DRR) project in 2010. In the current global climate a versatile, inexpensive radiation monitoring system is highly desirable.

A mobile-phone-size personal radiation monitoring system.

Experimental Study on Hybrid-ECC materials and High-Velocity Impact Response of Hybrid-ECC Panels

Dr Yixia (Sarah) Zhang and Prof L.C Zhang (UNSW)



Steel rebar reinforced concrete.

Defence related engineering structures are usually subjected to severe loading such as impact from the bullets and other projectiles. Fiber-reinforced engineered cementitious composite (ECC) is a very promising construction material with strong potential application in the protective structures due to their high shutter resistance, high strain capacity and high ultimate strength. This research investigated experimentally the material properties and impact resistance of an innovative hybrid ECC material reinforced with steel fiber and PVA fibers. The impact responses of the ECC panels along with panels made of other concrete materials including conventional high strength concrete, steel-reinforced concrete, and steel fiber reinforce concrete under high velocity impact are investigated.

Protective structures are often exposed to high-velocity impacts from in-service projectiles fired from weapons such as rifles, cannons, etc. The application of construction materials with outstanding impact resistance capability is essential to protect Defence or other protective structures against attacks. Reinforcing steel has been used in concrete to resist impact since the 19th century, and reinforced or prestressed concrete have been widely used in defensive structures until the present day, but usually with bulk wall thickness and volume so as to resist impact and blast. However, traditional concrete has low shatter resistance and is prone to scabbing, spalling and fragmentation due to an inherent weakness in resisting tensile stress, and this may pose risk to people or equipment nearby. Fibre-reinforced concrete (FRC), was concluded to be a competitive substitute for concrete in protective structures due to their high shatter resistance to impact with reduced scabbing, spalling, fragmentation, and zone of damage, and increased energy absorption property via distributed micro cracking comparing with the traditional concrete materials.

High velocity impact tests were conducted on panels made of conventional high strength concrete, steel rebar reinforced concrete, steel fiber reinforced concrete and the two new hybrid-engineered cementitious composites (ECCs) to test their impact resistance capability in both the laboratory environment using gas gun facilities and in the military environment. In laboratory tests the panels were subjected to impact from a small ogive-nose steel projectile, which was fired from a gas gun, travelling with an initial impact velocity ranging from 300 m/s to 657 m/s. A computer controlled high speed camera was used to record the impact process, the track of the projectile during impact, and the residual velocity of the projectile after perforation. The magnitude of the impact damage to the panels was evaluated from the measured damage parameters such as crater diameter, penetration depth and scabbing diameter after the impact testing. Double impact tests were also carried out.

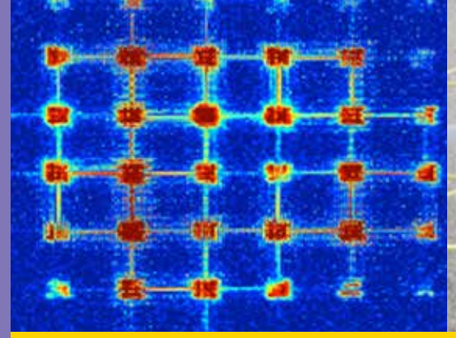
The material studies demonstrated that the new ECCs exhibits improved strength and strain capability which are both essential for improving impact resistance. Impact study showed that the new hybrid-fiber ECC material has an excellent impact resistance to projectile penetration, evidenced by a number of capacities such as the greater absorption of the impact energy from a projectile, the higher fiber bridging capability, the better durability under multiple impacts, localized damaged areas and fine cracks

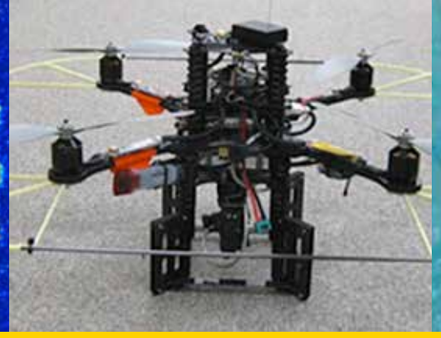
Contact us

If you would like further information, please contact the Research Office:

Research Enquiries:
Email: d.robinson@adfa.edu.au
Telephone: +61 2 6268 8497

The Research Office
The University of New South Wales Canberra
PO Box 7916
CANBERRA BC ACT 2610
Cricos Provider Code: 00100G • C120227





UNSW CANBERRA
THE UNIVERSITY OF NEW SOUTH WALES

Defence-related Research Grant Scheme 2011 Outcomes Report

Never Stand Still | Research Office

INTRODUCTION

UNSW Canberra (at the Australian Defence Force Academy) is the only national academic institution with an integrated defence focus, excelling in defence-related security and engineering research. UNSW has been ranked as one of the top 100 universities in the world in the 2012-13 Times Higher Education World University Rankings and 52nd in the 2012 QS World University Rankings, which are based on six factors: academic and employer surveys, staff-student ratios, research citations and the proportion of international staff and students.

UNSW Canberra is acutely aware that undertaking top-quality research is essential to providing the best possible education to the Australian Defence Force. The Defence-related Research Grant Scheme was established in 2006 to provide seed funding to academic staff to pursue defence-related research and to further promote research collaboration between UNSW Canberra and Defence. The results of the 2006, 2007, 2008, 2009 and 2010 projects are summarised in the respective Outcomes Reports and may all be accessed online at:

http://research.unsw.adfa.edu.au/publications

Project proposals under this funding scheme are assessed by the Faculty Research Grants Committee which makes recommendations to the Defence-related Research Advisory Committee for approval. The membership of the Defence-related Research Advisory Committee comprises equal representation from UNSW Canberra and the Australian Defence Force.

This report encapsulates the highlights and achievements of the research projects funded under this scheme in 2011.

OUTCOMES

A total funding of $100,000 was allocated to seven projects across the following schools: Engineering and Information Technology (SEIT); Humanities and Social Sciences (HASS); and Physical, Environmental and Mathematical Sciences (PEMS). Five Journal articles and eight conference papers have already been published from the projects with a further four accepted, two submitted and three more under review. In addition, research from the projects has resulted in the lodgement of a patent application. The projects involved one research associate in addition to the twelve chief investigators.

The ongoing work with image restoration from Dr Garratt's DRR has formed the basis for an Australian Research Council (ARC) Discovery Early Career Research Award (DECRA) application, which was submitted for funding commencing in 2013. We eagerly await this outcome.

Dr Hall has submitted a grant proposal with the Harry Frank Guggenheim Foundation for further funding to extend his project and to return more items to Vietnam.

DSTO has undertaken some preliminary evaluation of the dosimetry system developed by Prof Riesen.

Dr Sarah Zhang was awarded the Spitfire Defence fellowship based on her DRR research project. Her research, especially the impact test using real ammunition, was supported by the Defence Force.

A video talk by Dr Coleman on the ethical issues raised by military use of non-lethal weapons was originally presented at TEDx Canberra (TED.com), where it has been viewed more than 275,000 times.

The projects summarised within illustrate the wide range of research fields that have Defence relevance. They range from the development of Autonomous Underwater Vehicles (AUVs), military use on Non-Lethal Weapons (NLW), to the design a mobile-phone size personal radiation monitoring system

UNSW AUSTRALIA

DEPARTMENT OF DEFENCE

GROUP OF EIGHT MEMBER

Top from left-right:
Typical lightfield image obtained through the lenslets.
New quadcopter for testing algorithms.
Autonomous Underwater Vehicle (AUV) with integrated guidance & control

ADFA
AUSTRALIAN DEFENCE FORCE ACADEMY

Project Summaries

Development of Autonomous Underwater Vehicle (AUV) with Integrated Guidance and Control

Dr Sreenatha Anavatti and Dr Matt Garratt

The development of Autonomous Underwater Vehicles (AUVs) has grown over the years due to their increased applications in both Defence and Civilian environments. The major applications with Defence include manning the coastal line, reducing the human resources and avoiding the exposure of humans to dangerous and dirty missions. Due to the non-linear dynamics and changing operating conditions, the development of guidance and control systems, the brain of AUV provide a challenging task. This research aimed to provide an integrated framework for guidance and control of AUVS.

Autonomous Underwater Vehicle (AUV) with integrated guidance and control.

Examining the Ethical Issues Arising from the use of Non-Lethal Weapons by Military Personnel

Dr Stephen Coleman

Modern military personnel now engage in such a wide range of operations, it has been suggested that they ought to have access to Non-Lethal Weapons (NLW) to assist them in dealing with situations where the distinction between combatants and non-combatants tends to be blurred, such as in peace-keeping operations and counter-insurgency. However, military use of NLW raises a number of ethical problems, particularly with regard to the overuse and/or misuse of such weapons. This project examined such issues with the aim of determining whether or not such problems could realistically be addressed through standard military education and training programs.

Dr Coleman test-firing non-lethal rubber baton rounds, which are fired from a standard US military 30mm grenade launcher, on the firing range at Quantico, Virginia.

Operation Wandering Souls – The Vietnamese MIA project

Dr Bob Hall

The Operation Wandering Souls project aimed to identify by name as many as possible of those Viet Cong and People's Army of Vietnam soldiers who were killed in action in combat against Australian and New Zealand forces during the Vietnam War. Vietnam has a massive 'missing-in-action' (MIA) problem with government estimates putting the total number of MIAs throughout the country at well over 300,000. There is hardly a household in Vietnam that does not long to find the remains of a still missing relative and to put the 'wandering souls' of their loved ones to rest. The project aimed to help those Vietnamese families whose kin died in combat against Australian and New Zealand forces locate the burial sites of their MIAs and, if possible, to identify by name those buried therein.

During the war, Australian and New Zealand soldiers of the 1st Australian Task Force recorded the details of each of their battles with the Viet Cong. Carefully noted and filed were key bits of information - the date, place and number of enemy killed as well as a host of other information. Documents found on bodies were removed and sent to the Australian base at Nui Dat for intelligence examination. Occasionally, Australian or New Zealand soldiers also 'liberated' or souvenired documents and artefacts for their own purposes. Australian policy was to bury the enemy dead at the scene of battle.

The information recorded at the time, the documents examined for intelligence purposes and the 'liberated' items now enable us to locate the sites of battles where Viet Cong were buried. In 655 cases, the intelligence analysis of captured documents led to the recording of the names of those who died in these battles. The project team has now entered this information into a database, plotted the locations on Google Earth and provided the body of data to the Vietnamese government and people. The project team has also returned some 'liberated' items – a book of poetry, a diary and a scarf – to Vietnam. In an emotion charged event the diary and scarf were returned to the 85-year-old mother of the Viet Cong soldier who once carried them, by the Australian Vietnam veteran who kept them for forty-five years.

The project is ongoing and the research team now has plans to return other items to Vietnam in 2013.

Derrill de Heer (centre) accompanies the Australian Vietnam veteran Laurens Wildeboer in the emotional return of a diary and scarf to the 85-year-old mother of a Viet Cong soldier who died during the war.

Real-Time Image Registration for Military Application

Dr Matt Garratt, A/Prof Mark Pickering and Dr Andrew Lambert

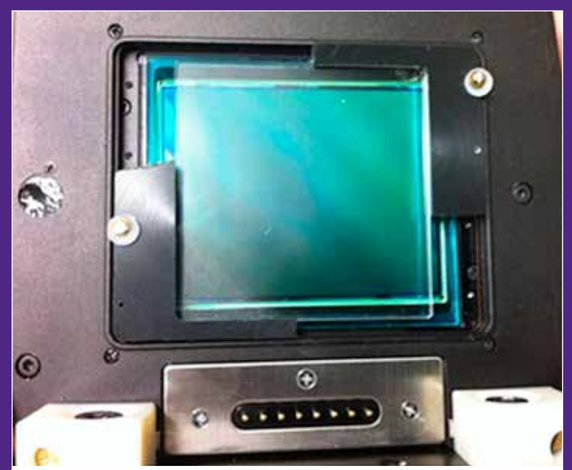
Image restorations forms a vital part of many image processing applications such as stereo vision, target detection and surveillance. All of these tasks have strong military applications and the ability to conduct them in real-time will provide a tremendous advantage. The aim of this project is to improve the performance of an existing gate array based real-time vision system by using a new low-complexity image restoration algorithm. The expected outcome of the project is an embedded implementation of a low-complexity image restoration algorithm which will be faster and more accurate than currently available systems.

Helicopter used for image registration experiments.

Visualisation of three-dimensional compressible flows around fighter aircraft and their components

Dr Harald Kleine, Dr Murat Tahtali and Dr Andrew Lambert

In this project, a new camera system was developed, built and tested, that will allow the user to visualise three-dimensional phase objects by not only capturing the intensity but also the direction of light rays. The relative positions of these objects with respect to each other and with respect to solid objects in the field of view can be determined from a single image taken with this camera. This camera can be used to record the three-dimensional variation of a compressible flow field, such as the one established around a supersonic jet fighter or within weapons bays of high-speed aircraft.



Camera with the lenslet array.

Defence-related Reasearch Grant Scheme - 2011 Outcomes Report