Welcome to Agriculture at ACFR

The University of Sydney’s Australian Centre for Field Robotics (ACFR) has been conducting research in autonomous remote sensing systems, and developing innovative robotics and intelligent software for the environment and agriculture community for over a decade.

Our current key research areas are:

- Development of crop intelligence and decision support systems for the vegetable industry
- Ground and aerial platforms for the grazing livestock industry
- Monitoring tools for managing tree crops
- Low cost robotics for supporting agriculture in developing countries
- Using agricultural robotics applications for STEM education

SwagBot demonstrated at Nevertire
Claire Burnett posted on Oct 30, 2017

SwagBot was recently demonstrated at a cattle station near Nevertire, NSW. SwagBot is a lightweight, electric vehicle designed to collect data on pasture and livestock. Local farmers were shown how SwagBot can automatically detect and spray weeds in grazing land using various spray attachments. The team also completed aerial surveying of the property which will be used to develop farm maps and resources for weed mapping.

Thank you to Central West Local Land Services for organising the event.
RIPPA Crop Interaction and Solar Endurance Field Trial

Mark Calleija posted on Oct 19, 2017

- Demonstration of the di-wheel concept for agricultural use
  created by Muhammad Esa Attia
  Agriculture | ACFR Aug 13, 2016

- SwagBot featured in media around the world
  created by Mark Calleija
  Agriculture | ACFR Aug 08, 2016

- Ladybird and Mantis featured in the latest Handbook of Robotics
  created by James P. Underwood
  Agriculture | ACFR Jul 12, 2016
The RIPPA team recently completed a successful field trial on a broccoli crop at Fresh Select farms in Werribee, Victoria. RIPPA's tasks included data collection, foreign object removal, a solar endurance characterization and testing a new deep learning algorithm for weed detection that was used for real time mechanical weeding.

Thanks to the team at Fresh Select for making this possible.

Mapping and counting mango fruit in orchards with machine vision, lidar and robotics

James P. Underwood posted on Sep 25, 2017

This video shows our latest results in mango fruit detection, localisation and mapping. The multi-sensor robot 'Shrimp' acquires data with a variety of different sensors, including lidar for tree canopy segmentation and colour vision for fruit detection and triangulation. This is arguably the world's most accurate system for mapping individual whole fruit in commercial orchards, while the fruit is still on the tree. Compared to post-harvest yield estimates for individual trees, the system counts accurately (linear fit, near unity slope of 0.96 and r^2 value of 0.89). The system has now been validated on two subsequent seasons, with the third planned later this year (2017). Scanning is performed 2 months before harvest time, meaning there's plenty of opportunity to use it for precision agriculture and on-farm decision making, towards optimised fruit production.
New Ladybird Video
Nathan Apps posted on Jul 26, 2017

The people from Jungle Creations have taken various footage of our Ladybird robot and made a viral video

https://www.facebook.com/techinsider/videos/837511499780541/
https://www.facebook.com/yooDesignStudio/videos/10154651031221044/

Digital Farmhand Video
Nathan Apps posted on Jul 17, 2017

This video shows footage from a recent demonstration of the Digital Farmhand robot at Richmond, NSW. Digital Farmhand is a low cost row crop robot aimed towards helping small scale farmers in Australia & overseas to perform crop analytics and automation of simple farming tasks. The design of the platform is based around the use of cheap low cost sensors, computing and manufacturing techniques which will allow the farmer to easily maintain and modify their platform to suit their needs.

The platform comes with an actuated 3 point hitch mechanism which allows various implements to be attached (similar to a tractor). Currently 4 implements have been manufactured for this platform. These include a sprayer, seeder, tine weeder and tow ball hitch.

More details visit http://sydney.edu.au/acfr/agriculture

ACFR demonstrates the Digital Farmhand platform to local farmers
Muhammad Esa Attia posted on Jun 25, 2017

On the 23rd of June 2017, ACFR was invited to a Local Land Services NSW field day event to present the work they have done over the last six months on a platform called the Digital Farmhand (Previously referred to as Di-Wheel). The event generated a large amount of interest within the local farming community with over 100 registrations for the event. During the event, the team presented:

- the project overview
- the design concept of the Digital Farmhand
- plant analytics via low-cost sensors (smartphone camera)
- the future vision of the project
- live demonstration of automated row turning via low-cost sensors (smartphone camera)
- live demonstration of a farming implement (spray boom) mounted on the digital farmhand

Below are some photos from the event. Link to news article here hawkesbury gazette
Digital Farmhand Featured in South West Voice
Nathan Apps posted on Jun 14, 2017

Details of the upcoming trial at Richmond of the Digital Farmhand Robot were
Robotic Arm With Pruner
Nathan Apps posted on May 22, 2017

We had a robotic arm lying around and thought we’d have some fun in the lab with a pneumatic pruner.

Shown here is a UR5 arm configured to navigate to way points on a tree. Once in position, the pruner is activated and a branch is removed.

Robotic Arm Picking Apples
Nathan Apps posted on May 22, 2017

We had a robotic arm lying around and thought we’d have some fun in the lab with a new type of gripper.

Shown here is a UR5 arm configured to navigate to way points on a tree. Once in position, the gripper is activated, then the arm twists and pulls the apple from the tree and places the fruit in a tray.

Orchard Autonomy and Precision Targeting Using RIPPA and VIIPA
Mark Calleija posted on May 12, 2017
We recently conducted a trial demonstrating the RIPPA robot working on an apple orchard in Three Bridges, Victoria, Australia. RIPPA operated autonomously up and down the apple rows and was able to change rows at the headlands by moving sideways. The trial demonstrated VIIPA autonomously and in real time detecting then targeting apples with variable rates of fluid.

The video below shows some of the experiments conducted on the trial:

Future applications of the technology include pest management, pruning, thinning, and pollinating in tree crop farming.

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Robots in developing countries - Trip to Indonesia

Muhammad Esa Attia posted on Nov 29, 2016

In early October, ACFR conducted a series of field trials in Lembang which is located on the outskirts of the city of Bandung Indonesia with the Di-Wheel
robot. The objective of the trip was to investigate how robotics can be deployed and utilised in a farming context in a developing country. As part of our investigation, a community of local farmers were interviewed to gain a better understanding of their requirements and their situation. We also visited a variety of engineering firms to understand the engineering capabilities within Bandung to support future field trials in that region.

Below are some videos and photos from the trip.

Tip: Hover cursor over the pictures for the caption
RIPPA Demonstrates Autonomous Crop Interaction
Mark Calleija posted on Oct 31, 2016
Over the last few months, the RIPPA robot has been working on several commercial vegetable farms around Australia. Various experimental autonomous crop interaction tasks have been demonstrated including:

- autonomous row following and data collection
- autonomous real time mechanical weeding
- autonomous real time variable rate fluid dispensing using VIIPA
- autonomous soil sampling and mapping


View the video below to see RIPPA in action.

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**Demonstration of the di-wheel concept for agricultural use**

Muhammad Esa Attia posted on Aug 13, 2016

The video shows the di-wheel being demonstrated at Cobbity farm (University of Sydney Campus) on a kale crop row.

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**SwagBot featured in media around the world**

Mark Calleija posted on Aug 08, 2016

Our initial tests of SwagBot last month have been featured in media outlets around the world.

National articles include: ABC Rural, 7 News, Today, SBS and 2Ser
Upcoming trials will focus on applying research toward autonomous farm activities including monitoring and interacting with plants and animals.

Introducing SwagBot - the world's first ROBOT COWBOY

The SwagBot is an all-terrain robot that could soon be running a farm
Ladybird and Mantis featured in the latest Handbook of Robotics
James P. Underwood posted on Jul 12, 2016

First field test of SwagBot
Mark Calleija posted on Jul 07, 2016

Meet SwagBot – our latest farming robot. SwagBot proved successful in its first field test. SwagBot successfully demonstrated the ability to operate in the rugged cattle station environment. Future trials will focus on applying research toward autonomous farm activities including monitoring and interacting with plants and animals.
Mary O’Kane reflects on Trends to inform smart choices in the June edition of FOCUS. (See pages 11-13)

Technology Quarterly discusses the future of Agriculture.
Farm Robots - These ARE the droids you're looking for.
Unknown User (dwil4966) posted on May 25, 2016
New Scientist video featuring ACFR robots.

NSW Chief Scientist & Engineer Breakfast Seminar - Presentation by Professor Sukkarieh
Sean McCracken posted on May 02, 2016

Salah Sukkarieh will be presenting the latest Farms of the Future work from the Australian Centre for Field Robotics, at The Science & Research Breakfast Seminar hosted by The NSW Chief Scientist & Engineer, Professor Mary O'Kane, on Wednesday 11 May 2016. Details of the invitation are attached:

Invite-SSukkarieh-print.pdf
Members of the House of Representatives Standing Committee on Agriculture and Industry visited the ACFR technical laboratory on 14 April 2016, to hear about the latest innovations around robotics in agriculture. The committee were briefed on the current research and how it is directly related to aiding farmers and growers, such as sensory and imaging processes to improve apple growing, the RIPPA robot which can target and destroy weeds in crops, and UAVs for identifying problem weeds in the Australian outback. This visit was part of the federal parliament public hearing on agricultural innovation. More information about the hearing can be found at http://sydney.edu.au/news-opinion/news/2016/04/12/federal-parliament-public-hearing-on-agricultural-innovation-at-.html

On April 6th 2016 RIPPA ran its first endurance trial and completed almost 22 hours of continuous operation using only battery and solar power. This was a major accomplishment and testament that the RIPPA design and ACFR Ag robots are focused on being a real solution to the farmer. The run began at 0530, 1 hour before sunrise and completed at 0317 the next morning, 9 hours after sunset. For the duration, RIPPA roved autonomously up and down the spinach crop rows imaging the leaves. RIPPA then waited until solar sufficiently charged the batteries and at 1000 it began where it left off and continued roving up and down the rows. The irrigation created muddy and uneven terrain at the row ends, which was no problem for RIPPA as you can see in the video. A fantastic effort from the ACFR team.

Thanks to Horticulture Innovation Australia and to Ed Fagan for hosting and
supporting us at his farm.
Multi-sensor data for mangos, avocados and macadamia research
A new three year program of high tech R&D for orchard management has begun, with the use of our Shrimp robot to acquire data from mango, avocado and macadamia orchards.


The data includes lidar, vision, thermal, hyperspectral, soil conductivity and natural gamma, demonstrating that there are many ways to view the humble tree:
First autonomous on-farm field trial of RIPPA™ and VIIPA™
Mark Calleija posted on Nov 04, 2015

RIPPA has just had its first ever field trial on a spinach crop at Mulyan farms in Cowra, NSW. We had RIPPA driving up and down the rows autonomously using satellite based corrections to within 4cm precision. You can see RIPPA and VIIPA in action on the WIN News Central West Facebook page here:

https://www.facebook.com/431557963627074/videos/845773805538819/

vegetables
First outdoor test of RIPPA™ and VIIPA™

Mark Calleija posted on Oct 09, 2015

Here's a video showing the first outdoor test of our new precision ground vehicle RIPPA™ (Robot for Intelligent Perception and Precision Application). VIIPA™ (Variable Injection Intelligent Precision Applicator) is shown autonomously shooting weeds at high speed using a directed micro dose of liquid. The first on-farm trial will be in Cowra late October, 2015!

Ladybird used for crop science

James P. Underwood posted on Sep 17, 2015

With its comprehensive array of sensors, and ability to precisely and repeatably scan the field, Ladybird is well suited as a scientific research tool to measure crop phenotypes. We're working with the South Australian Research and Development Institute (SARDI) to test this application.
APAL Speed Updating Talk  
James P. Underwood posted on Sep 14, 2015  

James Underwood gave a talk about autonomous information systems for tree crops, at the APAL speed updating session, alongside the National Horticulture Convention on the Gold Coast in June 2015. All the talks are available here.

tree-crops

Real-time targeted spot spray  
James P. Underwood posted on Feb 20, 2015  

This video shows the Ladybird performing targeted spot spray in real time. In this example, we show real-time results, first in the lab and then on a commercial vegetable orchard in Cowra, NSW, Australia. Ladybird detects the locations of seedlings in 3D using a stereo camera, then fires a small and
controllable volume of spray at each target. Coupled with algorithms shown in previous videos for automatic weed detection, this technology can be used to deliver tiny amounts of herbicide exactly where it's needed, anywhere on the farm, allowing a herbicide volume reduction to only 0.01% compared with conventional blanket spraying applications.

**Mammoth Rover Farm Trials**  
*James P. Underwood posted on Feb 18, 2015*

This video demonstrates the use of a reconfigurable rover for crop row monitoring.

**Happy holidays from Ladybird**  
*Mark Calleija posted on Dec 18, 2014*

The Ladybird robot and the Agricultural Robotics team at ACFR, The University of Sydney would like to wish everyone a safe and happy holiday period!

**Concept video: Using robotics to target weeds**  
*Mark Calleija posted on Dec 12, 2014*

Here's a demonstration of concept weeding methods using the robotic manipulator on our Ladybird robot. We’ll be doing some field trials early 2015!

**Ladybird scans corn and beetroot**  
*James P. Underwood posted on Nov 28, 2014*

We’ve just returned from another successful trip to the farm. Ladybird scanned corn to detect different varieties of weeds within the crop and beetroot just prior to harvest for yield monitoring and to evaluate the performance of different seed spacings. With harvest occurring all around us, it was great to see Ladybird operating autonomously alongside traditional farm equipment, showing that high-tech autonomous systems can easily coexist with current methods. The farm of the future is nearer than you might think.
ACFR Ag Robots featured in BBC News
James P. Underwood posted on Nov 27, 2014
IEEE RAS Summer School on Agricultural Robotics: Call for Participation

Robert Fitch posted on Nov 10, 2014

2-6 February 2015
Sydney, Australia

Applications due: 8 December 2014 (extended)
General enquiries: ssar2015@acfr.usyd.edu.au


The IEEE RAS Summer School on Agricultural Robotics (SSAR 2015) is a new summer school to be held at The University of Sydney, Australia over five days during the southern hemisphere summer, from 2-6 February 2015. SSAR 2015 is supported in part by the IEEE Robotics and Automation Society and The University of Sydney.

Agricultural robotics is an area of growing interest with the potential to bring about profound economic and social benefits. The School aims to promote robotics research that will enable safe, efficient, and economical production in agriculture and horticulture. The School will consist of presentations by world experts covering a broad range of topics in agricultural robotics, hands-on activities that encourage deep learning, and collaboration activities including a student poster session as well as several social events. Attendance is open to graduate students, postdocs, academics, and industry practitioners.

THEMES
The main technical objective of the School is to cover the motivation driving research in agricultural robotics, existing projects and results, and open research problems in key areas of agricultural robotics. Underlying research topics include systems design of outdoor platforms, perception in semi-structured outdoor environments, planning and control for single and multiple robot systems, and manipulators for harvesting and weeding.

The School will include presentations (and opportunities to interact with) representatives from the USDA, GRDC, Horticulture Innovation Australia Limited, and the Cotton Research and Development Corporation.

Please check the website for updates on the detailed technical program.

APPLICATION AND REGISTRATION
Applications will be processed as received. Spaces are limited so please send your application as soon as possible.
Applications are due by 8 December 2014.

General enquiries can be addressed to ssar2015@acfr.usyd.edu.au.

The Ladybird has arrived!

James P. Underwood posted on Jul 08, 2014

We've finished constructing the Ladybird and successfully commissioned it on a commercial veggie farm near Cowra, New South Wales. In two parts, the videos show the construction, automation, data and processing.

In part 1, we show the construction and testing of the vehicle on a
commercial vegetable near Cowra, New South Wales. The vehicle can drive autonomously up and down rows of a vegetable farm, gathering data that we think will be useful for growers to manage the farm. The Ladybird is a solar electric powered vehicle, and during our three day trip, we didn’t need to charge the vehicle once.

In part 2, we show some examples of the types of data we obtain and how it can be processed, to provide useful information to growers.

Managing snails with robots
Robert Fitch posted on Jul 05, 2014

Robert Fitch's presentation in Minlaton (SA) on “Robotics in agriculture now, and a potential solution for robotic snail management on the YP” was featured in the Yorke Peninsula Country Times newspaper.

Ladybird featured around the world
James P. Underwood posted on Jul 04, 2014

The Ladybird has captured the imagination of growers and the public alike, with online news and radio articles featured around Australia and globally. Links to stories here.
Ladybird featured on ABC Rural
James P. Underwood posted on Jun 25, 2014


Salah Sukkarieh named Ausveg "Researcher of the Year"
James P. Underwood posted on Jun 24, 2014

An information system for horticulture: almonds
James P. Underwood posted on May 29, 2014

We show an end to end system for acquiring high resolution information to support precision agriculture in almond orchards. The robot drives along the orchard rows autonomously, gathering laser and camera data while passing the trees. Each tree can be automatically identified, and information such as flower and fruit counts is produced. The information can be stored in a database, compared through the season and from one year to the next, mapped and displayed visually.

The Ladybird takes its first strides outdoors
James P. Underwood posted on May 28, 2014

Our first full motion test of the ladybird outside. We exercise the whole system for the first time, including translation, rotation and combined manoeuvres, including autonomous row alignment and following.

The Ladybird takes its first steps
James P. Underwood posted on May 15, 2014

Meet our newest robot, the Ladybird! A robot we have designed and built for the vegetable industry. In this video, you can see the internal framework and
components as it takes its first steps. Stay tuned for more videos as we develop the platform!

We have designed and built this robot as a new research platform to support Australia's vegetable industry. The omnidirectional wheel base allows traversal over most existing farm configurations, treading much more lightly over where existing tractor wheels currently run. In addition to the low weight of the vehicle, the ability to turn each wheel allows precision guidance and manoeuvrability, while minimising damage to the soil. In the undercarriage, the Ladybird carries a variety of optical sensors, including stereo and hyperspectral cameras, and the versatile robot arm enables development in a wide variety of applications, including spraying, weeding, thinning and of course to support harvesting research. We are looking forward to to our first tests on vegetable farm in the coming weeks.

CeBIT Future of Robots Exhibit
James P. Underwood posted on May 08, 2014

We exhibited a selection of our robots at CeBIT, with an emphasis on the future of agriculture.

Autonomy in the Apple Orchard
James P. Underwood posted on Apr 22, 2014

During our recent field trip to the Yarra Valley, we demonstrated autonomous row following for the trellis structured apple configuration. The system worked reliably, and we used it to gather data for yield prediction for approximately 30 rows of apples.

This video shows Shrimp driving fully autonomously in an apple orchard in the Yarra Valley, Australia. It uses a 360 degree lidar to guide it along the row (no need for GPS).

Unlike Mantis, the 2D lidars on Shrimp are looking sideways to scan the trees, so the 360 degree Velodyne sensor was used instead. To emulate a lower cost 2D lidar, only one of the 64 Velodyne lasers was processed. We used the autonomous system to obtain fruit yield data from approximately 30 rows of the farm without error.

This is a demonstration on our research platform, but the technology could easily be applied to any existing or new farm equipment, enabling smart farm vehicles to act as assistants to farmers.
Concept Video: Low-Cost Robot Arm for Harvesting

Robert Fitch posted on Apr 04, 2014

We are interested in using robotic manipulators for harvesting and weeding applications. This video from our field lab illustrates our concept for how a robot arm might look in performing a harvesting task.

Information systems for banana plantations

James P. Underwood posted on Mar 19, 2014

This video shows some of the data and first processing from our recent trip to a banana plantation. We gathered data from a banana plantation near Mareeba in the far north of Australia, at the end of 2013. Using Shrimp, we drove up and down rows of the plantation, acquiring 3D maps and image data.

Farmers typically use a system of coloured bags to denote the expected harvest date, which can be detected and mapped by the system. It is also hoped that in the future, growth rates of shoots or ‘suckers’ can be measured, to predict maturation times of the fruit directly, many months in advance.

Aquatic weed surveillance using robotic aircraft

Unknown User (khun7630) posted on Mar 18, 2014

We built and tested a prototype robotic aircraft and surveillance system to detect aquatic weeds in inaccessible habitats.

Read the report
Detecting Wheel Cacti

Unknown User (khun7630) posted on Mar 18, 2014

This project examined the role of unmanned aerial vehicles in detecting, classifying and mapping infestations of wheel cactus, Opuntia robusta, over large areas of rangelands in outback Australia.

Wheel cactus which is native and endemic to Mexico has now naturalised in South Australia, New South Wales and Victoria. It is often located in terrain which is difficult to access and monitoring and control by unmanned aerial vehicles and remote sensing offers significant potential.

Read the report
Tropical field trial featured in HAL's Hortlink Magazine
James P. Underwood posted on Mar 03, 2014

HAL Hortlink Autumn 2014
Our robotic herding story featured in Canadian Cattlemen magazine

James P. Underwood posted on Feb 28, 2014

Canadian Cattlemen: Robotic milkers, so why not robotic herders?

Autonomy in the Orchard

James P. Underwood posted on Feb 27, 2014

One of our research ground vehicles, Mantis, was used to successfully demonstrate autonomy at an almond orchard. The robot uses its forward looking laser to estimate the geometry of the tree foliage in front, enabling it to drive along the row without needing GPS. Additionally, it can detect people out in front, slowing down and coming to a safe halt.

The video shows a conceptual demonstration of how this could be used as a farmer assistance mechanism, whereby the vehicle could accompany a farmer, carrying heavy loads such as buckets of fruit, or towing other forms of equipment. Although demonstrated on one of our Perception Research Ground Vehicles (Mantis), the core technology can easily be applied to existing or new farm machinery.

GPS can be unreliable under canopied environments, due to occlusions between the vehicle and satellites. Therefore, forms of autonomy that require no GPS are likely to be more reliable.

Alligator Weed Detection Using UAV

Unknown User (khun7630) posted on Feb 27, 2014

We used a hexacopter to map and classify alligator weeds from an aerial perspective. In this trial a light weight hexacopter was used to detect alligator weed infestation. The final map product can be opened using Google Earth and can help the weed controllers to locate the infestation.
Woody Weed Detection, Classification and Control

Unknown User (khun7630) posted on Feb 27, 2014

"J3 Cub" the unmanned aerial vehicle (UAV) was used to detect and map various species the wood weed in Northern Queensland.

This trial aimed to provide a weed distribution map over a large area in Northern Queensland. During the trial we have mapped various woody weed including prickly acacia (Acacia nilotica), parkinsonia (Parkinsonia aculeate) and mesquite (Prosopis pallida). The map product can be used by the farmers to plan the control and eradication process.
Using camera data, we have developed algorithms to segment individual apples, and then use the apple count to perform apple yield estimation. Images are collected as "Shrimp" surveys the orchard. The algorithm classify and count apples in each image and provide yield estimation for each row "Shrimp" surveyed. This yield estimation can give the farmer an early indication of potential yield and allows the farmer to refine and optimise the farm operation.
Using lidar (laser) data, individual trees can be segmented, counted and mapped, allowing information on the farm to be associated per tree.

As “Shrimp” drives along a row of an orchard, 3D maps are built from laser data. From this, we can segment and recognise individual trees, which is useful for data management. For example, when combined with our yield estimation techniques, it allows us to measure and associate the yield of each individual tree. This can be used to track information, such as yield, over time and it can be used actively, for example, to target autonomous or computer assisted spray trucks with spray programs for each tree.
"Shrimp" was successfully used in a trial at the University of Sydney Dairy, to remotely herd groups of 20 to 150 dairy cows. The trial aimed to test the response of cows to the presence of a robot, and determine the feasibility of remote or autonomous herding using an unmanned ground vehicle. The cows were calm with the robot in their midst, and were willing to be herded into the dairy at a gentle pace, proving the potential of this technology. The story has captured the public's imagination, with media coverage around the world: Discovery Channel Canada, ABC Rural, BBC News, tested.com, cnet.com, International Business Times, and more.
dairy