The 2019 Australian & New Zealand Control Conference – ANZCC 2019

Auckland University of Technology

Auckland

27 – 29 November 2019

The 2019 Australian & New Zealand Control Conference – ANZCC 2019

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ANZCC 2019

Invitation Letter

An Invitation to attend the ANZCC 2019

The 2019 Australian & New Zealand Control Conference – ANZCC 2019

Auckland University of Technology, Auckland, New Zealand,

27 - 29 November 2019

Dear Fellow Academics, Researchers, and Students

We would like to cordially invite you to attend the 2019 Australian & New Zealand Control Conference – ANZCC 2019, 27-29 November 2019. This time it will be held at Auckland University of Technology (AUT), Auckland, New Zealand.

The conference provides researchers and practitioners to exchange ideas not only in the areas of control and automation, but also related areas such as large-scale data wrangling, robust and automated model building, and industrial control system security.

We are planning introductory short-courses prior to the conference proper, and also to have an industrial panel of control specialists to challenge and hopefully stimulate new control research directions.

AUT is the fastest growing university in New Zealand and the only technological university in New Zealand. AUT is a world-class, multidisciplinary institution leading the way in science, technology, business, design and innovation. The University's goals, priorities and the levers for change, are set out under the following strategic themes: teaching and learning; research and scholarship; staff; engagement with communities; and continuous development and capacity building. Thus, much of AUT's research is concentrated in its research institutes and centres, which are noted for their industry links, community service, and multidisciplinary approach.

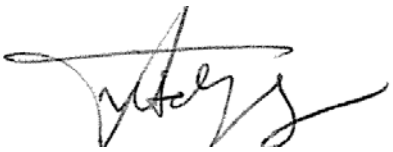
AUT has strategically invested by having state-of-the-art facilities and recruited top academic talent in Engineering, Computer and Mathematical Sciences to build a world-class teaching and research team.

This in turn has helped AUT to become ranked in the Top 300 of the Times Higher Education University Rankings within three years.

The ANZCC series have, by now, grown to an internationally recognised scientific event. We believe that ANZCC 2019 will raise the ANZCC series to the next level of international distinction.

I look forward to warmly welcoming you at ANZCC 2019.

Yours sincerely,



The ANZCC 2019 General Chair
Professor Tek Tjing Lie
Deputy Head of School (Research)
School of Engineering, Computer and Mathematical Sciences
6 ST Paul Street
WZ Building, AUT City Campus
Auckland 1010, New Zealand
Telephone: +64 9 921 9428
Email: tek.lie@aut.ac.nz

ANZCC 2019

Welcome Letters

The Australia and New Zealand Control Conference (ANZCC) Steering Committee Incorporated

Welcomes You To

Dear ANZCC 2019 Participant

On behalf of Australia and New Zealand Control Conference (ANZCC) Steering Committee Association Incorporated, it gives me a great pleasure to welcome you to ANZCC 2019.

It is a pleasure to acknowledge the Conference General Chairs, Professor Tek Tjing Lie and Associate Professor David Wilson, and their team, for the planning of the conference, and for ensuring that it will run smoothly.

On behalf of ANZCC Steering Committee Association Incorporated, I thank all the committee members, and reviewers for their input. Indeed, we are indebted to you for your volunteering effort to make the conference a rewarding experience.

Last but not least, I thank you for your participation, and for joining us at Auckland University of technology, Auckland, for a great ANZCC 2019, I wish you a most rewarding experience, and I look forward meeting you.

Best regards,

V. Sreeram

Professor Victor Sreeram
Chair, ANZCC Steering Committee Association Incorporated

Welcome to ANZCC 2019

It gives us great pleasure to welcome you to AUT and the "City of Sails" Auckland for Australia & New Zealand's premier symposium on control systems research & applications. Our special welcome goes to overseas participants for making ANZCC 2019 the scientific conference of their choice.

AUT is honoured to be given the opportunity to host ANZCC 2019. AUT is the fastest growing university in New Zealand and the only technological university in New Zealand. AUT is a world-class, multidisciplinary institution leading the way in science, technology, business, design and innovation. The University's goals, priorities and the levers for change, are set out under the following strategic themes: teaching and learning; research and scholarship; staff; engagement with communities; and continuous development and capacity building. Thus, much of AUT's research is concentrated in its research institutes and centres, which are noted for their industry links, community service, and multidisciplinary approach.

AUT has strategically invested by having state-of-the-art facilities and recruited top academic talent in Engineering, Computer and Mathematical Sciences to build a world-class teaching and research team. This in turn has helped AUT to become ranked in the Top 300 of the Times Higher Education University Rankings within three years.

We are grateful for your efforts towards submitting your paper to ANZCC 2019. All 78 submissions were subject to rigorous two-stage review process and finally 54 submissions were chosen in the technical program. We would therefore like to offer our thank-you to all paper co-authors and conference participants for making ANZCC 2019 a success.

The planning for ANZCC 2019 has taken 18 months and required a great deal of effort from the ANZCC Steering Committee led by our respectful colleague Professor Victor Sreeram. We successfully secured a technical sponsorship from IEEE and IFAC.

The Paper Review process was skilfully conducted by Professor Victor Sreeram, who is also the architect of the conference Final Program. The Conference web site was designed and enthusiastically & timely maintained by Clinton McKinnon. We are thankful to AUT's Event officer Selina Nihalani-Sharma for setting the ANZCC on-line registration page and overseeing the registration fee payment process. We are also grateful to a great assistance we received from Selina and her team for their skilful management of local arrangements. All other remaining tasks were unreservedly carried out by us and, thus, we accept the responsibility for any shortcomings.

We wish for you to enjoy ANZCC 2019 and the City of Sails. We are confident that ANZCC 2019's participants will have a rewarding conference experience and, thus, will become committed to participate in future ANZCC conferences and help us continue to nurture the ANZCC conference series in years to come.

Tek Tjing Lie	David Wilson	Victor Sreeram	Tom Moir
General Co-Chair	General Co-Chair	IPC Co-Chair	IPC Co-Chair

ANZCC 2019

Sponsors

Sponsorship Acknowledgment

The 2019 Australian and New Zealand Control Conference General Chairs, Professor Tek Tjing Lie and Associate Professor David Wilson, wish to acknowledge the generous support the Conference received from a number of its sponsors. The ANZCC 2019 would not have been a success without the sponsorship received.

Corporate Sponsors

Platinum Sponsors

AUT

Griffith UNIVERSITY

Technical Sponsors

Control Systems Society

IEEE

IFAC
INTERNATIONAL FEDERATION OF AUTOMATIC CONTROL

One of the world's best modern universities

AUT's mission is to create great graduates, and each member of our staff contributes to this. We offer exceptional learning experiences that prepare students to be successful wherever in the world their career may take them.

INTERNATIONAL FEDERATION
OF AUTOMATIC CONTROL

BECOME AN IFAC AFFILIATE!

If you are interested in Control Engineering you should become an

IFAC AFFILIATE

This gives you the following benefits

- **Free subscription to the IFAC Newsletter**
  - This bimonthly Newsletter contains information about IFAC's technical activities and forthcoming IFAC events all over the world.
- **Automatic inclusion of your name in our mailing lists for forthcoming events in your areas of interest**
  - IFAC organizes about 40 technical meetings all over the world each year
- **Subscription to the IFAC Journals at a reduced Affiliate rate**
  - Subscription forms can be obtained by marking the appropriate box on the on-line Affiliate Registration Form, or by writing to the IFAC Secretariat directly.
- **Contribution and participation in IFAC's technical work**
  - IFAC at present has more than 40 technical bodies covering all aspects of Automatic Control Engineering

How to join?

Make an on-line registration directly from the IFAC website:

https://www.ifac-control.org/

https://www.ifac-control.org/about/ifac-affiliate-registration

ANZCC 2019

Plenary Speakers

Professor Iven Mareels
Director, IBM Research Australia

Title: Smart Grids - A view from the last mile

Abstract:

The electricity grid is undergoing a paradigm shift. The classic grid goes back to the days of the first pioneers such as Edison, Westinghouse and Siemens and has little changed over a century of deployment. The classic electricity grid is a centralised system with few large power sources with inherently large inertia supplying over a large network a distributed base of many relatively small consumers, who are essentially in control of their demand. The new grid will have many distributed generators, using unreliable and variable primary energy (read solar energy), and using power electronics to inject power into the grid. Moreover, the roles of the consumer will change dramatically, and they will be able to participate in the electricity market in many different capacities, perhaps even sacrificing some of their control over their consumptive energy demand.

In the new grid, the engineering complexity is therefore significantly larger than in the classic grid. The sources are spatially distributed, demonstrate many different technologies and exhibit a greater range of different capacities, with generally less (temporal) reliability than is classically the case. Equally on the demand side technologies are changing, with an expanding electrical footprint as general personal transport becomes increasingly electrified. Moreover, new consumers (prosumers, and aggregators) and new services are entering the electricity energy market.

In engineered systems variability in supply is normally counteracted through buffers, and complexity requires more control to maintain the desired quality of service. The electricity grid is no exception. However, buffers require the consideration of energy as the primary quantity to manage rather than power. Moreover, distributed control requires more sensors and communication than hitherto has been necessary.

This talk presents an overview of the main issues, and through a control engineering lens develops how modern “internet-of-things” technology may enable the paradigm shift towards energy as the main guiding principle to control the grid, whilst maintaining the classic quality of service measures in terms of reliability, voltage and frequency regulation that we have come to enjoy. Remarkably this transition may even be realised whilst leaving the consumer in control of their demand, at least from an energy perspective.

Speaker Biography

Since February 2018, Iven Mareels is the Lab Director, IBM Research Australia. He is an honorary Professor at the University of Melbourne. Prior to this he was the Dean of Engineering at the University of Melbourne (2007-2018).

He received the PhD in Systems Engineering from the Australian National University in 1987, and the Master of Engineering (Electromechanical) from Gent University in 1982.

At IBM Research Australia he leads the development of the next generation of artificial intelligence, blockchain technologies and quantum computing software. The lab serves the IBM Research motto "Famous for science and vital to IBM". The application domains are health and medical systems, financial services, and the Internet-of-Things. The main implementation modality is to build on and to exploit IBM's AI, cloud, and edge computing assets.

Iven is a Commander in the Order of the Crown of Belgium, a Fellow of The Academy of Technological Sciences and Engineering Australia; The Institute of Electrical and Electronics Engineers (USA), the International Federation of Automatic Control, Engineers Australia and he is a Foreign Member of the Royal Flemish Academy of Belgium for Science and the Arts.

Dr Nigel Russell PhD, BTech (Hons), MIET
Fonterra Cooperative Group Ltd, Hamilton, New Zealand

Title: What 'Going Digital' means for industrial process control

Abstract

The last 20 years has seen the evolution of technology platforms to enable real-time advanced process control and optimisation solutions to be more accessible to process industries. Today the focus is the advancing Digital technologies and over the last few years there has been significant promotion of the Industry 4.0 technologies.

The industrial process control field is built upon relatively old technology and it is unlikely that anything new will suddenly replace these trusted, mature technology platforms. Industrial control engineers now face the challenge of integrating novel digital technologies with the traditional industrial process control systems.

This talk aims to give an industrial practitioner's perspective of the new technological trends and approaches, highlighting the likely changes in landscape for process control engineers and what will remain the same. The discussion will focus on how future real-time solutions might be developed and implemented in process industries what companies will need to embrace to remain competitive.

Speaker Biography

Nigel Russell has been with Fonterra 17 years working in the field of Advanced Process Control (APC). During that time he has both lead R&D initiatives as a Principal Engineer as well as managed the Fonterra APC team of 11 engineers. The APC team have developed, deployed and now support over 140 APC applications across Fonterra's operations. Prior to Fonterra, Nigel was employed with Invensys Process Systems in the UK delivering APC projects and training courses to customers across Europe and North America. His PhD, from Massey University, specialised in model predictive control. Currently Nigel has a role as Product Owner on a project to re-develop Fonterra's operational data historian from an in-house system to a cloud-based solution. This experience and his management of the APC team during the recent upsurge in interest in digital technologies has given him unique insight into the merging of control engineering with the changing digital technology landscape.

Rob Dexter

DCM Process Control, Australia-New Zealand

Title: Change in all aspects of controllability is accelerating. Can we manage the disparities this creates?

Abstract

All aspects of control are in a frenzy of change. Can we control it or will it control us?

Data availability and the ease of sharing it to large audiences is a huge driver of innovative control. Motivators vary hugely as do the consequences of control outcomes. This can have massive and rapid positive or negative consequences. Can we manage that?

Development of software tools and computing capacity make control of almost anything available to anyone. A natural consequence of this is the appearance of major disparities in the degree of control applied to different areas of life. Can this be reduced and how?

Let's look at two specific examples to clarify and explore the opportunities created for each of us.

Speaker Biography

Rob has worked in the Water /Wastewater sensing and control area most of his working life.

After taking almost all the science papers from Botany through Chemistry to Maths and Astro physics at Auckland Uni but not finding his niche, Rob changed to Electrical /Electronic engineering at ATI. While completing his NZCE he developed an intense interest in the conversion of physical realities such as light/energy/sound/chemistry into electronic signals and the power this gave to automating control of manufacturing processes.

He initially began his career in the Pulp and Paper industry focusing on real time control of chemical and physical "tree destruction" and resultant processes to turn that into paper. This introduced him to the rigour and quality control standards required to reliably convert comparatively random source materials and efficiently turn them into high quality, high consistency end products.

It wasn't long before a significant disparity became apparent. The knowledge and data-based process control used in making paper was completely at odds with the comparative lack of knowledge about the composition of the wastewater it generated and how to treat that despite it being part of the system. Recognition that the regulator and receiver of the waste had even less data available to protect the environment was a shock.

Addressing these two factors defined the focus of the next 30 years of Rob's life.

He started DCM Process Control in 1996 in Australia an in NZ in 2002. DCM has been a major research partner in many water and wastewater research programmes and developed the ability to measure many key water and wastewater parameters in real time. This spawned predictive control of coagulant dosing for water and wastewater, modelling and control platforms to mitigate sewer corrosion and the ability to pre-empt treatment plant demand and detect inhibition events in real time.

Reducing the knowledge disparities and using the outcomes to achieve co-operative, well executed control of water and wastewater treatment processes remains the focus of his work.

ANZCC 2019

Committees

ANZCC Steering Committee:

Victor Sreeram (Chair)
The University of Western Australia
Australia

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University of Auckland
New Zealand

Chris Pretty
University of Canterbury
New Zealand

Geoff Chase
University of Canterbury
New Zealand

Jennifer Dickson
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Australia

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Wei Xing Zheng
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Dragan Nesic
University of Melbourne
Australia

Ian R. Petersen
Australian National University
Australia

Iven Mareels
IBM Research
Australia

Jochen Trumpf
Australian National University
Australia

Ljubo Vlacic
Griffith University
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Michael Lees
Carlton United Breweries
Australia

Robi Malik
University of Waikato
New Zealand

Waleed H Abdulla
University of Auckland
New Zealand

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AUT
New Zealand

David Wilson
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New Zealand

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Victor Sreeram
Australia

Tom Moir
New Zealand

Treasurer:

Ljubo Vlacic
Australia

Web Master:

Clinton McKinnon
Australia

ANZCC 2019

Local Information

Conference venue:

ANZCC 2019 will be held at Auckland University of Technology (AUT), Auckland.

Auckland University of Technology began in 1895 with a roll of 30 as a school for children of the poor. The Auckland Technical School was housed initially in a cluster of small and cheerless buildings in Rutland Street, and it was not until 1906 that a start was made on construction of the first purpose-built facility. This fine, original building still stands in Wellesley Street. In its 108 years, the institution has experienced unimagined growth and change, including five changes of name, and on-going development.

In 1913 the Auckland Technical School became Seddon Memorial Technical College. By 1947 it had grown to become the largest secondary school in New Zealand, with a roll of 1800 day and 2500 evening pupils.

During the 1950s College leaders recognised the need to do more than cope with increasing enrolments. In order for New Zealand to keep pace with technological change and development, they realised it was necessary to broaden the scope of vocational education. In 1957 a decision was made to separate the secondary school functions of the College from its tertiary technical education functions. In 1960 a separate secondary college, now the Western Springs College, was opened and the Auckland Technical Institute (ATI) was formally established on the current Wellesley Campus.

The 1980s saw significant change. ATI took over the assets of the North Shore Teachers' College to establish the Akoranga Campus on the North Shore where the Faculty of Health and Environmental Sciences is now based. With the Education Act amendment of 1989, the Institute became bulk funded and, in the same year, changed its name to the Auckland Institute of Technology (AIT) to better reflect the achievement of its aspirations. Just two years later, AIT became the first polytechnic in New Zealand to offer a degree course — the Bachelor of Health Science (Physiotherapy).

The 1990s saw further significant growth. The number of full-time students doubled; blocks of downtown office space were leased to use as classrooms and offices; and two major teaching facilities on the Wellesley Campus — the School of Hospitality complex and the Science and Technology building were completed. The Ngä Wai o Horotiu Marae was also completed.

On 1 January 2000 the Institute gained university status, becoming the Auckland University of Technology (AUT). Since that date the University has continued to enhance its contribution through a growing portfolio of undergraduate and postgraduate programmes, and enhanced research activity.

AUT provides excellent facilities and environment for the conference.

Auckland University of Technology (AUT)

(City campus)
55 Wellesley Street East
Auckland 1010
New Zealand
Tel: + 64 9 921 9999
http://www.aut.ac.nz

AUT City Campus is in the heart of Auckland. It is AUT's biggest campus and home to most academic units and the central administration, including the Vice-Chancellor's office.

Getting There

On arrival in Auckland there are several ways of transporting yourself to your accommodation choice. The Conference venue is walking distance from most of the major hotels in the city.

By Cab/Taxi

Taxi and shuttle ranks are located outside the arrivals area (door 8) at the international terminal and outside the luggage collection area (door 4) at the domestic terminal. You can pre-book with one of the companies listed below or just turn up at the terminal ranks – taxis and shuttles are always available.

Indicative fares from the airport into the city is between NZ$60 – NZ$100 one-way for a taxi and between NZ$30 and NZ$40 per person for a shuttle. For specific fare pricing, contact the taxi and shuttle companies directly. The city centre and conference venue are located around 45 min (depending on peak traffic hours) from the airport by car.

Alert Taxis
Phone: +64 9 309 2000
Website: www.alerttaxis.co.nz

Auckland Combined Citicabs Taxis
Phone: +64 9 300 1111
Website: www.citicabs.co.nz

Auckland Co-op Taxis
Phone: +64 9 300 3000
Website: www.cooptaxi.co.nz

Corporate Cabs
Phone: +64 9 377 0773
Website: www.corporatecabs.co.nz

By Shuttle Service
Directly situated outside the terminal you will find Airport Shuttle Services which will accommodate up to 10 passengers travelling on route to various destinations within Auckland within a close proximity of each other. This service does take slightly longer than the normal trip direct into the city due to various stops of other passengers into Auckland, however, this is a significantly lower cost than that of hiring a private shuttle or taxi.

Super Shuttle
Freephone: 0800 SHUTTLE (0800 748 885)
Phone: +64 9 522 5100
Website: www.supershuttle.co.nz

By Bus

Airport-City-Airport
A regular 15-minute Airbus Express service is available from the airport for all travellers to Auckland's CBD and to the city's waterfront Downtown Ferry Terminal. This service stops outside the Mt Eden train station in both directions. Simply hop on and buy your tickets directly from one of our friendly drivers. Look out for the bright blue bus! Please note that on arrival in Auckland City you will be required to take a short taxi ride to your hotel of choice for accommodation.

On-site registration

Conference participants will receive a Registration Kit which will contain: a name badge, lanyard, lunch tickets, dinner ticket, and a Conference proceeding on USB.

Registration Inclusions

The ANZCC 2019 basic registration types, and their inclusions, are as follows:

Registration Type	Welcome Reception	Conference Dinner	Farewell Session	Lunch on Each Day	Morning & Afternoon Refreshments on Each Day	Proceedings on USB	The Main Paper Upload	An Additional Paper Upload
Full Registration	√	√	√	√	√	√	√	For a small additional fee
Student Registration	√	√	√	√	√	√	n/a	n/a

Registration Fees

All registration fees are listed in New Zealand dollars (NZD) and inclusive of 15%GST.

Registration Category	Early Bird	Standard	On-Site
	09 Sep – 24 Sep 2019	25 Sept – 26 Nov 2019	27 – 29 Nov 2019
Full Registration ACA, IEEE, IFAC, IEAust Members	700	800	900
Full Registration ACA, IEEE, IFAC, IEAust Non-Members	750	900	1000
Each Additional Paper Upload Fee	350	n/a	n/a
Student Registration ACA, IEEE, IFAC, IEAust Members	350	400	450
Student Registration ACA, IEEE, IFAC, IEAust Non-Members	400	500	550
Additional Dinner Ticket	100	120	n/a

Limitation of Liability in relation to ANZCC 2019

The ANZCC 2019 reserves itself the right to cancel ANZCC 2019 without notice or compensation in the event of any delay, default, failure or cancelation of implementation of any deliverable to or for the ANZCC 2019 which has been caused, directly or indirectly, by any incident of "force majeure".

For the purposes hereof, the term "force majeure" shall include but not be limited to the following:

- Any **act of nature such as fire, earthquake, hurricane, flood or adverse weather conditions**;
- Any strike, or other industrial action of any kind;
- Unavoidable breakdown or destruction of facilities or equipment including Power failure;
- Any failure of the ANZCC 2019 service provider to fully carry out their obligation towards the ANZCC 2019 Organiser;
- **Terrorist attack and/or a Cyber-attack**;
- Promulgation of any relevant legislation or regulation by local or national government;
- Any occurrence of any nature which renders it reasonably necessary for the ANZCC 2019 Organiser to cancel the ANZCC 2019 conference.

In such cases, the ANZCC 2019 Conference Organiser is freed of all responsibility and shall only be obliged to reimburse the payments received subject to deduction of any costs it has incurred in preparing the event. This limited liability only extends to the payments made directly to the ANZCC 2019 and not to payments made by the attendees to the hotel or airlines.

Refreshment Breaks

Tea, coffee and light refreshments are included in the registration fee and will be served during the time of Interactive sessions.

Lunch is also provided free of charge for all registered conference delegates on each and every day of the conference. Lunch tickets will be provided as a part of the Registration kit.

Social events

ANZCC Welcome Reception

Date: ~~Thursday~~ Wednesday ~~XXXXXXX~~ 27 November 2019

Time: 18:00 – 20:00

Venue: Auckland University of Technology, WZ Building

Opening Session

Date: ~~Friday~~ Thursday ~~XXXX~~ 28 November 2019

Time: 08:00 – 08:30

Venue: Auckland University of Technology, WZ Building, Room WZ416

Conference Dinner

Date: ~~Friday~~ Thursday ~~XXXXX~~ 28 November 2019

Time 19:00 – 21:00

Venue: Auckland University of Technology, WZ Building, Room WZ111

Award Presentations & Farewell Reception

Date: ~~Saturday~~ Friday ~~XXXXXXX~~ 29 November 2019

Time: ~~16:15 – 17:30~~ 18:00 - 19:30

Venue: Auckland University of Technology, WZ Building, Room WZ416

Wi-Fi

Wi-fi will be made available for the Conference Participants to use while at the Conference space.

General Information

Currency

Decimal currency is used in New Zealand (NZD) and currency units are dollars and cents. New Zealand notes are: $100, $50, $20, $10, $5. Coins are: $2, $1, 50, 20, 10, and 5 cents.

Weather

Auckland has a subtropical climate with heavy rain May–Dec. Summer and fall (Nov–Apr) are peak travel. You can visit the link provided below for more details.

https://www.timeanddate.com/weather/new-zealand/auckland

Time Zone

Auckland's time is 12 hours ahead of GMT.

Quarantine

New Zealand is free from many plant and animal diseases prevalent in other countries. Very strict quarantine rules apply to the importation of animals and plants which cannot be brought into the country without prior application. Animal and plant products are also restricted.

Health

Vaccinations are not required unless you have come from a yellow fever- infected country zone within six days prior to your arrival. You do not need any other health certificate to enter New Zealand. New Zealand has a high standard of hygiene and doctors and dentists are highly trained and hospitals are well equipped. In the event of illness, hotel staff can arrange a doctor for you.

GST Refund Scheme

New Zealand applies a tax to the purchase of both goods and services called the Goods and Services Tax (GST). The rate of tax that applies to taxable products and services is 15%. Tax is already included in the advertised prices. Non-New Zealander delegates may be eligible for a refund of GST via the Tourist Refund Scheme.

Travel Insurance

All visitors are encouraged to purchase personal travel insurance to ensure personal coverage in medical, hospitalisation and other unforeseen circumstances during their trip to New Zealand. The Conference organisers do not take responsibility for any delegate/visitor failing to insure.

Tipping

Tipping is not as widespread or regulated in New Zealand as it is in other parts of the world. Tipping is your prerogative, a reward for service. It is customary to tip hotel porters, and a gratuity of about 10% is usual in restaurants if good service is received. NO service charge is added to hotel or restaurant bill.

Electricity

The electrical supply is 240 volts, 50 Hz. The connection for appliances is a flat 3-pin plug. Most city hotels provide 110 volts for shavers.

Emergency Phone Number: 111

In the case of an emergency feel free to also contact

- **ANCCC 2019 Local Organiser, Selina Nihalani-Sharma by phoning +64 21 847 640**
- **ANZCC 2019 General Chair, Professor Tek Tjing Lie by phoning +64 21 813 661**

ANZCC 2019

Invitation to ANZCC 2020



An Invitation to attend

the 2020 Australian and New Zealand Control Conference

The City of Gold Coast, 26 – 27 November 2020, Australia

Since its inception in 2017, the ANZCC conference series has grown to a premier scientific control systems conference of the Asia-Pacific region. The Conference welcomes presentations of new developments in theory, analysis, simulation, modelling, experimentation, field operational tests of advanced control and decision-making algorithms and their deployments in numerous application areas.

The City of Gold Coast is a celebrated holiday experience set on one of Australia's most spectacular natural stages. From pure, adrenalin-packed fun to natural indulgence, the contrasts of Australia's Gold Coast unite to deliver every holiday experience you could desire in one friendly place.

The following manuscript submission types are sought:

- Contributing manuscripts; 4 – 6 pages
- Practitioners manuscripts; 2 – 6 pages
- Presentation only manuscripts; 1 – 2 pages
  These manuscripts will not be included in the Conference Proceedings. However, they will be a part of the Conference Program (if accepted) and their abstracts will be included in the Book of Abstracts which will be distributed to the conference participants

All accepted manuscripts will be published in the IEEE Xplore. Technical sponsorship is being sought from IEEE-CSS, IFAC and the Asian Control Association.

For further details please contact:

- the ANZCC 2020 General Chair, Professor Emeritus Ljubo Vlacic via l.vlacic@griffith.edu.au

or

- the ANZCC Steering Committee Chair, Professor Victor Sreeram via victor.sreeram@uwa.edu.au

ANZCC 2019

Campus Map

AUT CITY CAMPUS

55 Wellesley Street East, Auckland 1010

SCHOOLS

Art & Design – Level 3, WE building
Business & Economics – Level 1, WF building
Colab: Creative Technologies – Level 11, WG building
Communication Studies – Level 12, WG building
Engineering, Computer & Mathematical Sciences – Level 3, WZ building
Hospitality & Tourism – Level 3, WH building
Language & Culture – Level 8, WT building
Law – Level 6, WY building
Science – Level 5, WS building
Social Sciences & Public Policy – Level 14, WT building
Te Ara Poutama – Level 3, WB building

STUDENT HUB

Level 2, WA building
Phone: 0800 AUT UNI (0800 288 864)
Web: www.aut.ac.nz/studenthub

SERVICES AND FACILITIES

AUT International Centre – Ground Floor, WY building
AUTSA (Auckland University of Technology Student Association) – Level 2, WC building
Early Childhood Centre – Level 2, WA building via Gate 2
Estates Service Centre, Security – Corner St Paul & Wakefield St, WO building
Learning Lab – Level 3, WA building
Library – Level 4, WA building
PinkLime (print services) – Level 3, WA building
Student Counselling & Mental Health – WB204, WB building
Student Medical Centre – WB219, WB building
ubiq (formerly University Bookshop) – WC122, WC building

- Student Hub
- Student lounge
- Cafés
- Library
- Early Childhood Centre
- Gym
- Conference facility
- Intercampus shuttle bus stop
- Breast feeding and baby change room
- Mobility parks

ANZCC 2019

Program

ANZCC 2019 Technical Program Wednesday November 27, 2019

Welcome Reception
17:00-18:00 WRE WZ Building Foyer Registration
18:00-20:00 WWR WZ Building Foyer Welcome Reception

ANZCC 2019 Technical Program Thursday November 28, 2019

08:30-09:00 WZ Building Room WZ416 TRE
09:00-09:15 TOR WZ Building Room WZ416 Conference Opening Address

09:15-10:00 T1PL WZ Building Room WZ416 Plenary Speech 1: "Smart Grids - a View from the Last Mile" by Professor Iven Mareels, IBM Research Australia
10:00-10:15 WZ Building Foyer Coffee Break
10:15-12:45 TA1 WZ Building Room WZ416 Complex and Nonlinear Systems
12:45-13:15 TL_B WZ Building Foyer Lunch
13:15-15:30 TB1 WZ Building Room WZ416 Modelling, Filtering, and Networked Control
15:30-15:45 TPM_CB WZ Building Foyer Coffee Break
15:45-17:45 TC1 WZ Building Room WZ416 Control Applications

ANZCC 2019 Technical Program Friday November 29, 2019

08:30-09:15 F2PL WZ Building Room WZ416 Plenary Speech 2: "What 'Going Digital' Means for Industrial Process Control" by Dr. Nigel Russell, Fonterra Cooperative Group Ltd, New Zealand
09:15-10:00 F3PL WZ Building Room WZ416 Plenary Speech 3: "Process Control of Water and Wastewater Treatment" by Dr Rob Dexter, DCM Process Control, Australia-New Zealand
10:00-10:15 FAM_CB WZ Building Foyer Coffee Break
10:15-12:45 FA1 WZ Building Room WZ416 Linear Systems and Robust Control
12:45-13:15 FL_B WZ Building Foyer Lunch
13:15-15:30 FB1 WZ Building Room WZ416 Systems, Control, and Estimation

15:30-15:45 FPM_CB WZ Building Foyer Coffee Break
15:45-17:45 FC1 WZ Building Room WZ416 Learning, Fuzzy and Neural Systems
Closing Reception
18:00-20:00 FFR WZ Building Foyer

TA1 WZ Building Room WZ416

Complex and Nonlinear Systems (Regular Session)

Chair: Zhang, Jian — University of New South Wales

Co-Chair: Nurdin, Hendra I. — The University of New South Wales

10:15-10:30 TA1.1

A Collision-Free 3D Path Planning Strategy for Mobile Robots, pp. 1-4

Zhang, Jian — University of New South Wales

This work presents a collision-free 3D path planning strategy for the non-holonomic mobile robot control. The non-holonomic mobile robot travels through an unknown 3D environment with obstacles and reaches a given destination safely with no collisions. In addition, our approach enables to find the optimal path to the target efficiently based on the avoiding plane selected. The performance of the presented strategy is demonstrated via computer simulations and good results are obtained.

10:30-10:45 TA1.2

Trajectory Tracking for Vessels with the Kinematic Model Using Complex Networks, pp. 5-10

carmona, roberto — Korean Research Institute of Ship and Ocean Engineering

Sung, Hong Gun — Korean Research Institute of Ship and Ocean Engineering

Kim, Young Shik — Korean Research Institute of Ship and Ocean Engineering

In this work, we study the trajectory synchronization for vessel networks applying complex dynamic networks theory. The network nodes were modeled by the kinematic equation in the horizontal plane, without considering environmental disturbances. To solve the trajectory synchronization problem, first the error synchronization is calculated as the difference between both vessel's trajectories; secondly, to achieve the trajectory synchronization in the vessel network this error must converge to zero. The error convergence is proven by the Lyapunov analysis proposed in the present work. The control law design for this method is determined by the structural network properties, as well as the dynamic characteristics in the nodes, based on the simple choice of a coupling constant. One of the advantages of this method is the study of the coordinated motion between the vessels through the linear systems analysis. To maintain the separation distance between the ship trajectories a repulsion coefficient is added into the control law. Furthermore, numerical simulations are carried out using Matlab, showing a fast convergence on the error synchronization on the network. Finally, the obtained results in the present work, suggest the use of this method to solve the trajectory tracking problem where the nodes include the dynamic equation for the vessel networks.

10:45-11:00 TA1.3

Control Systems Challenges for Nuclear Fusion, pp. 11-11

Rapson, Chris — AUT

Nuclear fusion has incredible potential as an energy source, but there are still many technical problems to solve. This presentation will explain some of the challenges associated with controlling something 10 times hotter than the core of the sun.

11:00-11:15 TA1.4

A Strategy for Fault Tolerant Control of Full-State Feedback Linearisable Nonlinear Systems, pp. 12-17

Hanafi, Ainain Nur — Universiti Teknikal Malaysia Melaka

Seron, Maria M. — The University of Newcastle

De Dona, Jose — The University of Newcastle

We present a scheme for fault detection and isolation (FDI) and controller reconfiguration (CR) in full-state feedback linearisable nonlinear systems subject to actuator faults. The nonlinear plant is feedback-linearised and then controlled by a linear controller that satisfies a requirement of set-point tracking. Ultimate bound arguments are used to detect and isolate the healthy or faulty system operation. Then, the virtual actuator methodology is applied to reconfigure the control laws after the occurrence of actuator faults. This proposed scheme is illustrated by an example of the Chua circuit.

11:15-11:30 TA1.5

A Physics-Based Attack Detection Technique in Cyber-Physical Systems: A Model Predictive Control Co-Design Approach, pp. 18-23

Chamanbaz, Mohammadreza — Singapore University of Technology and Design

Dabbene, Fabrizio — Politecnico Di Torino

Bouffanais, Roland — Singapore University of Technology and Design

In this paper a novel approach to co-design controller and attack detector for nonlinear cyber-physical systems affected by false data injection (FDI) attack is proposed. We augment model predictive controller with an additional constraint requiring the future---in some steps ahead---trajectory of the system to remain in some time-invariant neighborhood of a properly designed reference trajectory. At any sampling time, we compare the real-time trajectory of the system with the designed reference trajectory, and construct a residual. The residual is then used in a nonparametric cumulative sum (CUSUM) anomaly detector to uncover FDI attacks on input and measurement channels. The effectiveness of the proposed approach is tested with a nonlinear model regarding level control of coupled tanks.

11:30-11:45 TA1.6

On Robustly Positively Invariant Sets and Coordinate Transformations for Discrete-Time Nonlinear Systems: A Tutorial, pp. 24-29

Kaldmäe, Arvo — Tallinn University of Technology

De Dona, Jose — The University of Newcastle

This paper addresses the problem of characterizing analytically invariant sets for nonlinear discrete-time systems. Different notions of invariance are defined and the effect of state and input transformations on these invariant sets is studied. The main part of the paper considers finding robustly positively invariant sets for feedback linearizable (with respect to the disturbance input) systems. It is shown that taking the system into controller canonical form, simplifies the computations considerably. The ultimate goal is to find the minimal robustly invariant set, which is described through the notion of reachability. Finally, it is shown that convex invariant sets of discretized systems using the Euler forward discretization scheme are also invariant for the respective continuous-time system. The purpose of this article is to present some known as well as some new results, illustrated by simple examples, in a tutorial, self-contained form, invoking only basic set theoretic methods and coordinate transformations.

11:45-12:00 TA1.7

Some Results on Control Design of Non-Minimum Phase Bilinear Systems, pp. 30-35

ahmadin, ahmadin — Department of Mathematics, University of Airlangga, Surabaya

NAIBORHU, JANSON — FMIPA, Institut Teknologi Bandung

Saragih, Roberd — Institut Teknologi Bandung

In this paper will be studied the control design of the non-minimum phase bilinear system with relative degree greater than 1 and less than , is dimension of the system. The research is done on bilinear systems with particular class using coordinate transformation. From these results it can be classified that the bilinear system under review can have non-minimum phase, minimum phase and weak minimum phase

12:00-12:15 TA1.8

Guidance Method without Terrain Information for an

Exploration Rover, pp. 36-41

Chiba, Sosuke	Nihon University
Uchiyama, Kenji	Nihon University
Masuda, Kai	Nihon University

This paper describes the guidance method considering the irregular land of the planetary exploration rover in an unknown environment. Some exploration methods in the environment such as many obstacles and uneven ground surfaces have been proposed. In this study, we propose a guidance method to detect and avoid the area that would be difficult to detect with an external sensor such as a camera or a radar. An observer based on Disturbance Accommodation Control (DAC) is used to detect the areas. The potential function method is applied to the avoidance of the area. Furthermore, we perform self-location estimation and map construction using EKF-SLAM in a more realistic environment. We conduct the numerical simulation and the experiment to show the effectiveness of the proposed guidance method.

12:15-12:30 TA1.9

Stability Analysis of the Sinusoidal Orbits of a Nonlinear Proportional and Resonant Current Regulator for Islanded Microgrids, pp. 42-47

Nurdin, Hendra I.	The University of New South Wales

Conventional control of islanded microgrids employ power electronic inverters as voltage controllers. However, inverters can also be operated in current control mode with a number of desirable features. One proposed scheme is to use a proportional and resonant controller to regulate the inverter output current and use the phase estimate from a PLL as a nonlinear feedback signal. It was recently shown that for linear time-invariant loads this current control scheme has a family of sinusoidal orbits in its state space, producing a sinusoidal output at the inverter. However, it remained an open question as to whether this family of sinusoidal orbits is stable in the sense that it attracts nearby trajectories in the system's state-space. In this work we establish stability theorems for the sinusoidal orbits, providing explicit conditions for their stability.

12:30-12:45 TA1.10

Heterogeneous Target Assignment to Robotic Fiber Positioner Systems, pp. 48-53

Macktoobian, Matin	Swiss Federal Institute of Technology in Lausanne (EPFL)
Gillet, Denis	Swiss Federal Institute of Technology in Lausanne (EPFL)
Kneib, Jean-Paul	Swiss Federal Institute of Technology in Lausanne (EPFL)

The target assignment methods applied to robotic fiber positioners are only applicable to homogeneous sets of targets to be observed. However, different batches of robotic fiber positioners available at the focal plane of a telescope can be simultaneously used in various applications. Those applications may be intrinsically different, say, some may seek astronomical observations, whereas the others may focus on space operations such as space debris detection. The current target assignment algorithms cannot handle these heterogeneous scenarios. This paper proposes an efficient multilinear algorithm to assign robotic fiber positioners to heterogeneous targets. We classify the targets based on their required exposure times. We also take the priority of observations compared to other operations into account during an assignment processes. Our algorithm assigns a bundle of robotic positioners to each dynamic target to efficiently detect it. We finally illustrate our algorithm's application using a simulated example.

TB1 WZ Building Room WZ416

Modelling, Filtering, and Networked Control (Regular Session)

Chair: Rapson, Chris	AUT
Co-Chair: Segundo Sevilla, Felix Rafael	ZHAW

13:15-13:30 TB1.1

Detection of Frequency Deviations for Monitoring of Power Systems, pp. 54-56

Segundo Sevilla, Felix Rafael	ZHAW
Dobrowolski, Jean	Zurich University of Applied Sciences ZHAW
Obusevs, Artjoms	Zurich University of Applied Sciences ZHAW
Korba, Petr	Zurich University of Applied Sciences

In this work an algorithm for identification of power system frequency deviation is presented. The proposed approach can be used to monitor frequency measurements from syncrophasor measurement units (PMU) and to store data only for important events and save storage in the local server. The detection algorithm use a sliding window that rise a flag if the measured frequency deviates from a predefined set point. If the alarm flag is constant over several sliding windows, an event is captured and locally stored for further analysis. To demonstrate the effectiveness of the proposed approach, real PMU measurements from the Swiss power system are used as input.

13:30-13:45 TB1.2

Game-Theoretic Control for Actuator Coordination in Wireless Sensor and Actuator Networks, pp. 57-62

HU, ZICHEN	Auckland University of Technology
SEET, BOON-CHONG	Auckland University of Technology

In wireless sensor and actuator networks (WSANs), the actuators often need to coordinate their actions in response to an event occurrence. A good coordination among actuators can balance energy consumption, prolong network lifetime, and improve real-time performance of WSANs. However, it can be challenging to determine the best cooperating team of actuators in WSANs. In this paper, distributed game-based control algorithms for actuator-actuator coordination are proposed. The game is played between multiple actuators each time an action task needs to be performed in an event area. Hence, the task allocation and execution problem in WSANs can be transformed into a utility assignment problem in a multi-player coalition game. The proposed algorithms implement effective task execution by determining the best cooperating work team among the actuators through a game theoretic strategy. The algorithms are evaluated in terms of energy consumption, network lifetime and task completion time.

13:45-14:00 TB1.3

A Fast Session Key Generation Scheme for LoRaWAN, pp. 63-66

Chen, Xingda	RMIT University
Wang, Jidong	RMIT University
Wang, Liuping	RMIT University

LoRaWAN is one of the emerging Low Power Wide Area Networks being developed for IoT applications which can be applied to Industrial Control System (ICS). The latest LoRaWAN release v.1.1 uses Advanced Encryption Standard Electronic (AES) with 128 bits key for encryption and authentication. The release has a security framework which covers the end devices, LoRaWAN gateways, network servers and application servers. In its key management part, the key generation is recommended, but not clearly specified. However, the key generation is a very important part of the security key management scheme, as it will affect the soundness of the whole security framework. In this paper, a new key generation scheme for LoRaWAN is proposed. The scheme has been shown that it not only has high computing efficiency but also meets the randomness requirement of the security key. The proposed scheme can enhance the LoRaWAN security framework if it is adopted in its future release.

14:00-14:15 TB1.4

Networked Yaw Rate Tracking Control of Four-Wheel-Independent-Drive Electric Vehicle in Steering Process, pp. 67-71

Gao, Zifan	Shanxi University
Zhang, Dawei	Shandong University
Zhu, Shuqian	Shandong University
Jia, Xinchun	Shanxi University
Zhang, Bao-Lin	China Jiliang University

This paper deals with the networked yaw rate tracking control problem of a Four-Wheel-Independent-Drive electric vehicle (FWID-EV) in steering process. Based on the dynamics of the FWID-EV and an expected yaw rate, an augmented state-space representation is presented to model the tracking control system with disturbance inputs. An interval input delay system is used to describe the networked yaw rate tracking control system subject to network-induced delays and data losses. By constructing an augmented Lyapunov-Krasovskii functional according to the form of second-order Bessel-Legendre inequality, a new bounded real lemma is derived and the networked H_{infty} tracking control design result is established by solving linear matrix inequalities. Two numerical examples are provided to verify the obtain results.

14:15-14:30 TB1.5

Psychoacoustically Motivated Active Noise Control at Remote Locations, pp. 72-75

Munir, Muhammad Waqas	The University of Auckland
Abdulla, Waleed	The University of Auckland
Ardekani, Iman	The University of Auckland

Active noise control (ANC) is an effective way to cancel the low-frequency noise. The conventional ANC system creates the ‘zone of quiet' by minimising the mean square error (MSE) at the location of an error microphone. However, in practical applications, sometimes it is not possible to achieve the noise attenuation at the desired location due to physical constraints limiting locating the error microphone at certain points. Similarly, the performance of the conventional ANC system also compromises when the impression of audio sensation on human auditory does not match the numerical values of the system. It is because the human ear has complicated psychoacoustic properties. In this paper, we present a new psychoacoustically motivated ANC system for a remote location. Noise weighting filters are incorporated into remote ANC to improve the audio sensation of the residual noise. The performance of the purposed system is evaluated by computer simulation, and the perceptual loudness is selected as a performance criterion for the psychoacoustic assessment of residual noise.

14:30-14:45 TB1.6

System Identification of Fixed Wing UAV with Multi-Segment Control Surfaces, pp. 76-81

Sattar, Abdul	RMIT University
Wang, Liuping	RMIT University
Mohamed, Abdulghani	RMIT University
Panta, Ashim	RMIT University
Fisher, Alex	RMIT University

For a fixed-wing unmanned aerial vehicle flight in turbulent environments, distributing aerodynamic load of single aileron through multiple segments can provide rapid actuation, precise roll and heave control while also having the potential to improve yaw response for tail-less (flying wing) aircraft. This paper investigates the identification of small unmanned aerial vehicle (SUAV) via aileron (two segments) instead of the conventional control. Only roll axis is considered in this paper given it represents the most sensitive axis to atmospheric disturbances. The multi-segment aileron is configured as a multi-input and single-output system and each segment is regarded a control input. Experiments are conducted in a Wind Tunnel to determine the frequency responses of the system and the corresponding transfer functions. The experimental results and the mathematical models indicate that interaction between various aileron surfaces is nonlinear. An understanding of this non-linearity aids future development of precise maneuverability, energy efficient control and highly stable operation under severe air turbulence.

14:45-15:00 TB1.7

Port Hamiltonian Modelling and Control of a Micro-Channel, pp. 82-87

Cisneros, Nelson E	Universidad De Concepcion
Rojas, Alejandro	Universidad De Concepción
Ramirez, Hector	Universidad Federico Santa Maria

This paper presents the model of a micro-channel using a port-Hamiltonian system approach. The model is represented by a series of tanks and pipes interconnected in series. These hydraulic elements can be interpreted as basic elements equivalent to electric components such as capacitors, inductance and resistors. Based on this model we design a controller using the total hydraulic-mechanical energy as a local Lyapunov function. The objective is to control the level of the micro-channel in some arbitrary point inside the channel.

15:00-15:15 TB1.8

Modelling the Glucose-Insulin System of Type 2 Diabetes Patients Using ARMAX Models, pp. 88-93

Martinovic, Barbara	Aalborg University
Leth, John	Aalborg University
Knudsen, Torben	Aalborg University, Denmark
Aradottir, Tinna Bjork	Technical University of Denmark
Bengtsson, Henrik	Novo Nordisk A/S

This paper investigate the use of ARMAX models to describe the glucose-insulin system of type 2 diabetes patients. The parameters of the ARMAX models are estimated using clinical data of 416 type 2 diabetes patients. A variety of parameter combinations has been investigated and no significant change in fitness values and test statistics were found. Moreover, partially due to the delay parameter no conclusive models were found leading to the conclusion that other aspects (such as non-linearities) has to be taken into account when models of the glucose-insulin system are based on time series.

15:15-15:30 TB1.9

Fault Detection Problems in a Behavioral Framework, pp. 94-98

Li, Wangyan	University of New South Wales
Yan, Yitao	University of New South Wales
Bao, Jie	The University of New South Wales

This paper studies the fault detection problem in a system behavioral framework. The fault detection problem is formulated in the context of system behavioral and extended to the setting with existence of faults and exogenous disturbance. The corresponding Kernel representation of the fault detection problems in the setting of the behavioral theory framework is developed.

TC1 WZ Building Room WZ416

Control Applications (Regular Session)

Chair: De Dona, Jose	The University of Newcastle
Co-Chair: Stol, Karl	University of Auckland

15:45-16:00 TC1.1

Cascade Attitude Control of Hexacopter with PI and Disturbance Estimation, pp. 99-103

Zhu, Yuankang	RMIT University
Wang, Liuping	RMIT University
Poksawat, Pakorn	RMIT University

Unmanned Aerial Vehicles (UAVs), known as drones and quadcopters, have been widely used in military and civilian usages, including filming, fields of delivery, national defense and mission enforcement. This paper deals with proportional and

integral(PI) control of a hexacopter in cascaded structure with observer estimation. The inner-loop control systems use PI controllers while the outer-loop control systems use proportional control with an estimator for the turbulent disturbance. Experimental results have shown the validity of the proposed method.

16:00-16:15 TC1.2

Fuzzy Tuner Based Modified Cascade Control for Electromagnetic Levitation System, pp. 104-109

Gandhi, Ravi — PhD, Scholar, Nirma University

Adhyaru, Dipak — Professor & Head, Instrumentation Engineering, Nirma University

This research work presents the modified cascade control scheme using the Fuzzy Tuner. The proposed control structure is implemented for the Electromagnetic Levitation System (EMLS). This EMLS is a group of the highly nonlinear, unstable and electromechanically coupled system. The conventional cascade control with PID and PI controllers as primary and secondary loops is one of the widely used control approaches for the EMLS. However, the constant gains of the conventional cascade control structure may not provide the proper stabilization of the levitating object in the presence of the nonlinearities and the payload disturbances. Hence, Fuzzy Tuner is incorporated for the automatic tuning of the controller gains based on the ITAE criterion. Additionally, the nonlinear estimator is hybridized with the scheme to provide an online estimate of the vertical velocity of the EMLS. Also, the feed-forward compensator is introduced to compress the effect of the variation of the operating conditions. The experimental hardware is utilized to perform the stabilizing control and tracking control operations. The vertical payload disturbance in the range of 0-40 % is considered to check the efficacy of the proposed modified cascade controller.

16:15-16:30 TC1.3

Cascaded Attitude Control for Heterogeneous Multirotor UAS for Enhanced Disturbance Rejection, pp. 110-115

Hoshu, Ayaz Ahmed — RMIT University

Fisher, Alex — RMIT University

Wang, Liuping — RMIT University

Multirotor unmanned aircraft systems (UAS) have enjoyed much popularity of late due to their excellent manoeuvrability, VTOL capability, precise hovering, simple deign and satisfactory speed. But they do lack in terms of energy efficiency and endurance when compared to helicopter and fixed wing counterparts. This paper explores a heterogeneous multirotor configuration which attains the benefits of both helicopter and multirotor. The design employs a single large central rotor for the lift and three tilted small boom rotors for control. Three single loop PI cascade control system is designed to control the attitude of the rotorcraft. Motor dynamics of each rotor are also considered in the multirotor model and a novel motor control loop is implemented for enhanced disturbance rejection in turbulent environment. The presented configuration has been explored previously mainly focusing on energy efficiency but reported degraded attitude performance of the UAV. This work mainly focuses on the control system strategies to improve the robustness and stability of the system. We demonstrate the proposed control strategy with stable attitude performance, reference tracking and disturbance rejection by means of Simulink simulation. Deigning prototype is also in progress which will demonstrate its flight.

16:30-16:45 TC1.4

Remarks on Quaternion Neural Networks with Application to Trajectory Control of a Robot Manipulator, pp. 116-121

Takahashi, Kazuhiko — Doshisha University

This paper presents a quaternion neural network-based controller for a robot manipulator that can be used to investigate the possibility of using quaternion neural networks in practical applications. The quaternion neural network, which synthesises the control input for tracking an end-effector of the robot manipulator to the desired trajectory, assumes the role of an adaptive-type servo controller in a control system. Two types of network, such as feed-forward quaternion neural network and a recurrent quaternion neural network, were used to design servo-level controller and their performances were compared. Numerical simulations for controlling a three-link robot manipulator are performed to evaluate the characteristics of the proposed controllers and to demonstrate the feasibility as well as the effectiveness of the proposed controllers.

16:45-17:00 TC1.5

An Analytical Dynamics Approach for Nonlinear Trajectory-Tracking Control of Quadrotors: Numerical and Experimental Results, pp. 122-127

Mendes Souza, Pedro Henrique — University of Auckland

Stol, Karl — University of Auckland

This paper presents an alternative approach for nonlinear trajectory-tracking control of quadrotor unmanned aerial vehicles (UAVs) based on analytical dynamics and quaternion theories. The equations of motion of constrained mechanical systems are reinterpreted as a solution for obtaining an explicit nonlinear control law. In addition, practical control aspects and the impact of nonidealities are investigated by providing qualitative and quantitative comparisons between simulated and experimental results. Numerical simulations demonstrate the efficacy of the proposed controller to track desired trajectories with very small tracking error for simple as well as aggressive or sharp trajectories. Using common open-source solutions, real-world implementation feasibility, performance, and limitations of the control method are discussed.

17:00-17:15 TC1.6

Evaluation of a Multi-Rate Predictive Control Strategy for Adaptive Optics Systems, pp. 128-132

Cranney, Jesse — The University of Newcastle

De Dona, Jose — The University of Newcastle

Rigaut, Francois — Australian National University

Korkiakoski, Visa — Australian National University

In this paper, we implement and evaluate the performance of multi-rate predictive control for Adaptive Optics systems. The multi-rate strategy yields considerable performance improvements in the case of low-magnitude guide stars and in the presence of wave-front sensor read-out noise, since the wave-front sensor exposure time can be increased to provide useful signal-to-noise ratios without having to limit the temporal bandwidth of the deformable mirror (as is the case in a single-rate control approach). Simulations performed on an end-to-end numerical Adaptive Optics simulation package are presented to demonstrate the advantages of the approach.

17:15-17:30 TC1.7

Motion Prediction for Teleoperating Autonomous Vehicles Using a PID Control Model, pp. 133-138

Prexl, Maximilian — Technical University of Munich

Zunhammer, Nicolas — Technical University of Munich

Walter, Ulrich — Technical University of Munich

Teleoperating autonomous vehicles is challenging due to latency and bandwidth constraints. In order to increase operator safety and situation awareness, techniques similar to motion planning for control of autonomous cars in dynamic environments have been adapted for aerial vehicles in this study. An overview of a novel concept based on reconstruction of the environment, user handling, and predictive modeling will be given. The working principle of predictive motion for teleoperating vehicles is explained and key metrics are introduced to compare changes of model parameters. A proportional-integral-derivative (PID) control model has been developed and integrated into the concept. The concept has been evaluated based on flight simulations as well as with actual test flights. The sensitivity of the PID parameters and the impact of the correct estimation of the predicted latency were investigated. The concept has been successfully been demonstrated with a DJI M600 hexacopter. The analysis indicates a high sensitivity for the P-component and low sensitivity for I and D components for an accurate prediction. Latency analysis shows

that underestimation of the real latency does not have as high an impact as overestimating it and that the model fits best for latencies below 250 ms. The here presented model is a novel approach to handle the predicted motion of teleoperated vehicles and shows promising results in accuracy and parameter sensitivity.

17:30-17:45 TC1.8

Trajectory Tracking of a Quadrotor Using TID Controller, pp. 139-144

DEVEERASETTY, KRANTHI KUMAR	Shenzhen Institutes of Advanced Technology, Chinese Academy of S
Zhou, Yimin	Shenzhen Institutes of Advanced Technology, Chinese Academy of S
Han, BO	Shenzhen Institutes of Advanced Technology, Chinese Academy of S

In this paper, a TID controller is applied for the trajectory tracking of a quadrotor. The mathematical model of the control system is derived and compared with the traditional PD (Proportional-Derivative) controller. In order to improve the control precision of the UAV, the controller is designed by selecting the proper tuning parameters. To explore the effectiveness of the proposed controller, dynamic responses of a UAV obtained by using the TID controller and the validation of the results compared with the PD controller. The control performances are analyzed by using MATLAB/Simulink model.

FA1 WZ Building Room WZ416

Linear Systems and Robust Control (Regular Session)

Chair: Khandelwal, Shubham — Indian Institute of Technology Hyderabad

Co-Chair: MORI, Kazuyoshi — The University of Aizu

10:15-12:45 FA1.1

Positive-Real Truncated Balanced Realization Based Frequency-Weighted Model Reduction, pp. 145-147

Kumar, Deepak — Motilal Nehru National Institute of Technology Allahabad

Zulfiqar, Umair — The University of Western Australia

Sreeram, Victor — Univ. of Western Australia

Imran, Muhammad — National University of Sciences & Technology

Muda, Wan Mariam Wan — School of Ocean Engineering, Universiti Malaysia Terengganu,

Jazlan, Ahmad — Faculty of Engineering

Wu, Ai-Guo — Harbin Institute of Technology (Shenzhen)

In this paper, a new frequency-weighted positive real balanced truncation technique is presented by using a combination of frequency-weighted model reduction with the positive real-truncated balanced realization (PR-TBR). The proposed technique yields passive reduced-order model for a given passive high order model with single-sided weighting only. The simulation results of the proposed technique are shown by using an example problem of RLC ladder network.

10:15-12:45 FA1.2

Interval Switched Positive Observers for Discrete-Time Switched Positive Systems under Arbitrary Switching, pp. 148-151

Otsuka, Naohisa — Tokyo Denki Univ

Kakehi, Daiki — Tokyo Denki University

In this paper, we consider the two types of interval switched positive observers for discrete-time arbitrary switched positive linear systems under the assumption that the initial state of the switched system is between known lower and upper bounds. Firstly, the interval full-order switched positive observers for discrete-time switched positive linear systems are studied. Next, the interval reduced-order switched positive observers for the same switched positive linear systems are studied.

10:15-12:45 FA1.3

Dissipativity Analysis for Linear Systems in the Behavioural Framework, pp. 152-156

Yan, Yitao — University of New South Wales

Bao, Jie — The University of New South Wales

Huang, Biao — University of Alberta

This paper develops dissipativity conditions for linear time-invariant (LTI) systems in the behavioural framework. The behaviour of a system is characterised by its persistently exciting trajectories. For the dissipativity conditions, both the supply rate and the storage function are represented using quadratic difference forms (QdFs) using past steps. We show that it is possible to define an LTI system of arbitrary length using trajectories with low order of excitation. The system can be defined in a similar way as an image representation and the dissipativity conditions can hence be derived using a similar logic. The conditions are presented in the form of linear matrix inequalities (LMIs).

10:15-12:45 FA1.4

On Finitely Determined Minimal Robust Positively Invariant Sets, pp. 157-162

Seron, Maria M. — The University of Newcastle

Olaru, Sorin — CentraleSupélec

Stoican, Florin — Politehnica University of Bucharest

De Dona, Jose — The University of Newcastle

Kofman, Ernesto — Departamento De Control, FCEIA, UNR

For linear, time invariant stable systems with additive state disturbances that are bounded by polytopic sets, we establish connections between the minimal robust positively invariant set (mRPI) and ultimate-bound invariant (UBI) sets. We first identify cases for which the mRPI set is finitely determined. We then apply those cases to address the dual problem of finding (i) the A matrix of an LTI system, (ii) a disturbance set and (iii) a projection matrix, for which a given UBI set is a projection of the mRPI set associated with those three elements. Finally, these results are combined to iteratively compute converging outer approximations of the mRPI set associated with a given system via a sequence of sets that are projections of finitely determined mRPI sets in lifted spaces.

10:15-12:45 FA1.5

Two Coprime-Like Factorizations for Obtaining Stabilizing Controllers, pp. 163-168

MORI, Kazuyoshi — The University of Aizu

In this paper, we present a criterion of stabilizability of plants without coprime factorization for plants with equal number of inputs and outputs. This consists of factorizations of plants. Principally it requires precisely two coprime-like factorizations. We parametrize stabilizing controllers based on the criterion and also present their applications.

10:15-12:45 FA1.6

Feedback Linearization Based Adaptive Higher Order Sliding Mode Control, pp. 169-172

AUGUSTINE, MIDHUN — Indian Institute of Technology Delhi

In this paper, a feedback linearization based higher order sliding mode controller is proposed in which the switching gains are modified adaptively. The proposed method reduces the switching gain thereby reduces the control effort. Simulation of the proposed control law is carried out in DC motor speed tracking applications.

10:15-12:45 FA1.7

Detuning Iterative Continuous Cycling Based Multi-Loop PI Control for Multivariable Processes, pp. 173-178

Khandelwal, Shubham — Indian Institute of Technology Hyderabad

Detroja, Ketan — Indian Institute of Technology Hyderabad

Multivariable systems are universal and unavoidable in practice. Designing a PI controller for such multi-input multi-output system is challenging. In most cases, the complexity of a design method increases significantly beyond 2x2 systems. Therefore, along with effectiveness and robustness of the controller, simplicity and easy scalability of the design method are some of the key requirements from a control system design method. We propose a Detuning Iterative Continuous Cycling (DICC) method for decentralized PI control of MIMO processes. The proposed DICC design utilizes the idea of continuous cycling (CC) for obtaining the ultimate parameters (UPs) for the effective open-loop transfer functions (EOTFs). While for TITO systems the controller settings can be easily derived for the EOTFs, controller tuning for higher dimensional systems is challenging due to complicated EOTF dynamics. Therefore instead of EOTFs, it is proposed to use the effective transfer function (ETF) description of the large scale MIMO system. The ETFs are used to obtain the UPs during the closed loop CC test. Thereafter detuning based control design is proposed for obtaining multi-loop PI controller settings. The wide applicability, effectiveness, simplicity and easy scalability of the proposed DICC method has been demonstrated by considering various 2-,3- and 4- dimensional MIMO systems. Further,

robustness of the proposed design has also been tested by introducing a plant-model mismatch.

10:15-12:45 FA1.8

A Karhunen-Loeve Expansion for One-Mode Open Quantum Harmonic Oscillators Using the Eigenbasis of the Two-Point Commutator Kernel, pp. 179-184

Vladimirov, Igor G. — Australian National University
James, Matthew R. — Australian National Univ
Petersen, Ian R. — Australian National University

This paper considers one-mode open quantum harmonic oscillators with a pair of conjugate position and momentum variables driven by vacuum bosonic fields according to a linear quantum stochastic differential equation. Such systems model cavity resonators in quantum optical experiments. Assuming that the quadratic Hamiltonian of the oscillator is specified by a positive definite energy matrix, we consider a modified version of the quantum Karhunen-Loeve expansion of the system variables proposed recently. The expansion employs eigenvalues and eigenfunctions of the two-point commutator kernel for linearly transformed system variables. We take advantage of the specific structure of this eigenbasis in the one-mode case (including its connection with the classical Ornstein-Uhlenbeck process). These results are applied to computing quadratic-exponential cost functionals which provide robust performance criteria for risk-sensitive control of open quantum systems.

10:15-12:45 FA1.9

The Low-Sensitivity Control with Robust Stability Using Multiplex-Feedback Control System for a Time-Delay Plant Having a Varying Number of Unstable Poles, pp. 185-189

Koyama, Daisuke — Gunma University
Hashikura, Kotaro — Gunma University
Kamal, Md Abdus Samad — Gunma University
Yamada, Kou — Gunma Univ

In this paper, we propose a design method of the multiplex-feedback control system having low-sensitivity and robust stability for a single-input/single-output time-delay system with a varying number of poles in the closed right half plane. The low sensitivity control has high-performance of input-output property. However, it is well-known that the low-sensitivity control often cannot maintain the control system robust stability. According to Yamada, there is a low sensitivity control system design method maintaining robust stability for a single-input/single-output minimum-phase system with a varying number of unstable poles. In addition, Yu et al. expand the result of Yamada and propose a design method of the multiplex-feedback control system that has low-sensitivity characteristics less than a conventional two-degree-of-freedom control system. In this paper, we expand the result of Yamada and Yu et al. and propose a design method of the multiplex-feedback control system with robust stability that has low-sensitivity characteristics less than a conventional feedback control system for a single-input/single-output time-delay plant having a varying number of unstable poles.

10:15-12:45 FA1.10

On Design of H_{infty} Structured Controller for Decentralized Control Systems, pp. 190-193

Guan, Yanpeng — Shanxi University
Zheng, Wei Xing — Western Sydney University

In this paper the problem of H_{infty} structured controller design is addressed. The considered problem arises when selection of actuators in decentralized control systems leads to that some rows of the controller gain matrix should be zero. However, the design of controllers with sparse structure is essentially a combinatorial problem that is hard to handle. Towards this end, this paper adopts a mixed-integer programming method to tackle the resulting row-cardinality constraint. The direct mixed-integer programming method is utilized to assist in designing row-sparse H_{infty} state feedback controllers for large-scale distributed systems.

FB1 WZ Building Room WZ416

Systems, Control, and Estimation (Regular Session)

Chair: TAYLOR, DAVID GLENVILLE — Auckland University of Technology
Co-Chair: AUGUSTINE, MIDHUN — Indian Institute of Technology Delhi

13:15-15:30 FB1.1

Channel-Specific Frequency-Limited Model Reduction, pp. 194-196

Zulfiqar, Umair — The University of Western Australia
Sreeram, Victor — Univ. of Western Australia
Imran, Muhammad — National University of Sciences & Technology

The frequency-limited model reduction techniques aim to construct a model of significantly lower order which approximates the original higher order model accurately within some specified frequency interval. In this paper, we propose a frequency-limited model reduction technique for multi-input and multi-output systems wherein a different desired frequency region can be specified for each input -output channel. The reduced order model thus obtained ensures superior accuracy within the frequency regions specified for each input-output channel. A numerical example is presented to demonstrate the applicability and the efficacy of the proposed algorithm.

13:15-15:30 FB1.2

Output Feedback Control of Dynamic Supply Chains Via Interval-Like Demand Prediction Schemes, pp. 197-202

Liu, Liping — China Jiliang University
Zhang, Bao-Lin — China Jiliang University
Sun, Jian — China Jiliang University
YAN, Tianhong — China Jiliang University
Zhang, Dawei — Shandong University
huang, zuqing — Guangzhou University

This paper is concerned with output feedback control to reduce the bullwhip effect of a dynamic supply chain system based on an interval-like demand prediction scheme. By introducing an interval-like time-varying delayed state signal to predict the order variations of downstream sites and taking into account the parametric perturbations, the dynamic supply chain is modeled as an uncertain linear discrete-time system with interval-like time-delay. Then, output feedback control scheme is proposed to improve the performance of the supply chain system. A sufficient condition to the existence of the output feedback controller is derived. It is found from simulation results that the designed output feedback controller can effectively stabilize the supply chain system with interval-like time-delay and parametric perturbations. Moreover, if the introduced interval-like time-delays are chosen properly, the bullwhip effect of the system can be reduced significantly.

13:15-15:30 FB1.3

Vehicle Trajectory Prediction with Integrating a Physics Based Method and a Data-Based Method, pp. 203-203

Choi, Wansik — Pusan National University
Ahn, Changsun — Pusan National University

The physics and data-based methods are used to predict the trajectory of vehicles. To improve prediction performance, we suggest data-based methods using a deep learning model and a simple integration method. The integration method is the weighted sum, and the weights are extracted from the root mean square error of two methods. It shows enhanced results by taking the strength of both methods. The root mean square error of 0 to 3 seconds is less than 3 meter, and 3 to 6 seconds is less than 6 meter.

13:15-15:30 FB1.4

Evasive Steering Control Using Model Predictive Control,

pp. 204-204

Park, Yeayoung	Pusan National Univercity
Nam, Hyunsik	Pusan National University
Ahn, Changsun	Pusan National University

The usual model embedded in MPC for steering control is vehicle dynamics without steering dynamics because such steering dynamics are ignorable in usual maneuvers. However, the dynamics of the steering system need to consider when a maneuver requires high angular velocity. Therefore, this paper proposes MPC model include steering and vehicle model that can provide information on disturbances and voltage.

13:15-15:30 FB1.5

A Formation Maintenance and Reconstruction Method of UAV Swarm Based on Distributed Control with Obstacle Avoidance, pp. 205-209

Fu, Xiaowei	Northwestern Polytechnical University
Pan, Jing	Northwestern Polytechnical University
WANG, Haixiang	Northwestern Polytechnical University
Gao, Xiaoguang	Northwestern Polytechnical University, China

This paper studies the problem of formation maintenance and reconstruction of UAV swarm with obstacle avoidance. Firstly, a collision prediction mechanism is introduced to determine whether each UAV needs to avoid obstacles or not. Secondly, by designing the position and speed consistency control law between UAVs, each UAV and the virtual leader, combined with the obstacle avoidance mechanism based on the artificial potential field method, the swarm formation control and maintenance algorithm with obstacle avoidance is realized. Finally, the formation transformation is realized by changing the relative positional relationship between each UAV and the virtual leader. The simulation results show that the UAV swarm can generate, maintain and reconstruct the expected formation in a real-time distributed manner while avoiding obstacles.

13:15-15:30 FB1.6

A Distributed Formation Control Method of Swarm UAVs Based on Artificial Potential Field and Consensus Strategy, pp. 210-214

Fu, Xiaowei	Northwestern Polytechnical University
WANG, Haixiang	Northwestern Polytechnical University
Pan, Jing	Northwestern Polytechnical University
Gao, Xiaoguang	Northwestern Polytechnical University, China

This paper studies the formation control of swarm UAVs and designs a new distributed control method. Each UAV only needs to consider the information of its neighboring UAVs and the virtual leader. By constructing a new artificial potential function, virtual attractive and repulsive forces are generated between UAVs, so that the UAVs can maintain the desired distance during flight. On this basis, the relative positional relationship between each UAV and the virtual leader is designed using the consistency method, so that swarm UAVs can generate and maintain the basic formation. The simulation results of formation generation and formation maintenance illustrates the effectiveness and rationality of the method.

13:15-15:30 FB1.7

Friction Pre-Sliding Control and Sliding Impulse Compensation, pp. 215-220

TAYLOR, DAVID GLENVILLE	Auckland University of Technology

Precision position control in order of micro metres demands that friction is either compensated for or included in the control system loop. The dynamic friction models including Dahl, LuGre, Elasto-plastic and Generalized Maxwell-Slip (GMS) have been shown to model friction. Each of these dynamic models have the state variables of bristle displacement (z) and bristle displacement velocity dz/dt. They each have an equation that relates the bristle displacement velocity to the sliding velocity (v). This principle is disputed. It is shown that the presliding friction force can be analytically calculated from the applied electrical force, without having to have any relationship of the sliding velocity to the bristle displacement velocity. This leads to a feed back control system for presliding bristle displacement, without actual measurement of it. The dynamic friction models are currently used in real time control to provide feed forward compensation. Feed forward compensation is pre-emptive in that it provides anticipated friction force based on the planned velocity. A new control system strategy and method of overcoming the sliding friction forces called “impulse control” is developed which can be applied pre-emptively. Impulse control means the control of the time integral of a state variable. The term is not used to refer to control by short force pulses in this paper. The impulse control strategy is more generally applicable than just for the control of systems with frictio

13:15-15:30 FB1.8

Dynamic Programming Based Optimal Control of Discrete Time Switched Linear Systems, pp. 221-224

AUGUSTINE, MIDHUN	Indian Institute of Technology Delhi
Patil, Deepak	Indian Institute of Technology Delhi

Optimal control of switched systems deals with the design of an optimal switching signal and control input for switched systems. In this paper, an optimal switching feedback law with a finite number of switching is proposed for an asymp- totically stabilizable discrete-time switched linear system with at least one controllable subsystem. The algorithm uses dynamic programming based approach for minimizing the quadratic cost.

13:15-15:30 FB1.9

Data-Based Modelling of the Arteriovenous Fistula Eligibility (AFE) System for Wall Shear Stress Estimation, pp. 225-230

Golesorkhie, Farya	Griffith University
Barnes, Zachary	Griffith University
Yang, Fuwen	Griffith University
Loree, Howard	Flow Forward Medical, Inc
Franano, F. Nicholas	Flow Forward Medical, Inc
Vlacic, Ljubo	Griffith University
Tansley, Geoff	Griffith University

The AFE System is a medical device intended to dilate the cephalic vein by increasing the blood flow and wall shear stress (WSS) in the vein over a period of 10-14 days prior to creation of an arteriovenous fistula (AVF) for haemodialysis as a means of increasing eligibility for AVF surgery and reducing rates of AVF failure. During treatment, maintaining WSS around 4 Pa in the treated vein is desirable to provide optimal vein wall stimulation while avoiding wall injury that could lead to venous stenosis. Developing a model of the AFE System and the related venous circulation could help design a control system for maintaining a WSS in the treated vein during the period of treatment when the vein is increasing in diameter. Using a broad application of the Hagen-Poiseuille law, WSS calculation could be based on differential pressure and the flow rate. The AFE System pump was characterised in a test rig utilising sensors and a data acquisition system for measuring mechanical parameters. A data-based model of the AFE pump has been developed and is presented in this paper which includes pump head estimation based on flow rate or electrical current, and motor speed measurements. All data fitted the developed relationships well, with a correlation coefficient of 93% or above.

Learning, Fuzzy and Neural Systems (Regular Session)

Chair: Marattukalam, Felix	The University of Auckland
Co-Chair: Narayanan, Ajit	Auckland University of Technology

15:45-17:45 FC1.1

Ethical Judgement in Intelligent Control Systems for Autonomous Vehicles, pp. 231-236

Narayanan, Ajit — Auckland University of Technology

The role of ethical judgement in autonomous control systems is gaining increasing prominence. In particular, there is increasing concern about 'killer robots', drones that can kill on their own, and intelligent autonomous vehicles such as driverless cars. Recent incidents involving autonomous vehicles in which humans have been killed or injured have raised questions about whether such vehicles can have an ethical dimension to their behavior so that they know when it is right or wrong to take over control from a human driver or hand control back, no matter how advanced their embedded artificial intelligence and sensor technology. This paper describes a fuzzy control approach to machine ethics that shows how it is possible for an ethics architecture to be part of a control system to calculate when taking over from a human driver is morally justified. One major advantage of the approach is that such an ethical reasoning architecture can generate its own data for learning moral rules and thereby reduce the possibility of picking up human biases and prejudices.

15:45-17:45 FC1.2

Modelling an Adaptable Multi-Objective Fuzzy Expert System Based Transmission Network Transfer Capacity Enhancement, pp. 237-242

Oladeji, Ifedayo Ramon — Auckland University of Technology (AUT)

Zamora, Ramon — Auckland University of Technology (AUT)

Lie, Tek Tjing — Auckland Univ. of Tech

The need to enhance the performance of existing transmission network in line with economic and technical constraints is crucial in a competitive market environment. This paper models the total transfer capacity (TTC) improvement using optimally placed thyristor-controlled series capacitors (TCSC). The system states were evaluated using distributed slack bus (DSB) and continuous power flow (CPF) techniques. Adaptable logic relations was modelled based on security margin (SM), steady state and transient condition collapse voltages (Uss, Uts) and the steady state line power loss (Plss), through which line suitability index (LSI) was obtained. The fuzzy expert system (FES) membership functions (MF) with respective degrees of memberships are defined to obtain the best states. The LSI MF is defined high between 0.2-0.8 to provide enough protection under transient disturbances. The test results on IEEE 30 bus system show that the model is feasible for TTC enhancement under steady state and N-1 conditions.

15:45-17:45 FC1.3

Generalized Simulated Annealing with Sequentially Modified Cost Function for Combinatorial Optimization Problems, pp. 243-248

Chen, Jiayin — The University of New South Wales

Nurdin, Hendra I. — The University of New South Wales

Recent efforts to develop hybrid quantum-classical algorithms for solving combinatorial problems have rekindled interest in revisiting heuristic classical optimization algorithms and exploring possibilities for improving them. A popular approach for finding good solutions to combinatorial problems is local search. In spite of its efficiency, if the search space is rugged, local search often gets trapped in unsatisfactory local optima. On the other hand, global search meta-heuristic algorithms, such as classical simulated annealing, guarantee asymptotic convergence in probability distribution to global optima. Despite its theoretical appeal, practical performance of classical simulated annealing is often sensitive to implementation details. In this paper, we revisit classical simulated annealing and propose a generalization in which the annealing is guided by a sequentially modified cost function. We prove asymptotic convergence to global optima and give an example choice of the modified cost function. We test the proposed algorithm with this example modified cost function on the traveling salesman problem. Numerical results suggest that the performance of this method is more robust to the initial temperature choice. Furthermore, the method demonstrates a significant efficiency gain without compromising its performance.

15:45-17:45 FC1.4

Towards Q-Learning the Whittle Index for Restless Bandits, pp. 249-254

Fu, Jing — The University of Melbourne

Nazarathy, Yoni — The University of Queensland

Moka, Sarat Babu — University of Queensland

Taylor, Peter Gerrard — University of Melbourne

We consider the multi-armed restless bandit problem (RMABP) with an infinite horizon average cost objective. Each arm of the RMABP is associated with a Markov process that operates in two modes: active and passive. At each time slot a controller needs to designate a subset of the arms to be active, of which the associated processes will evolve differently from the passive case. Treated as an optimal control problem, the optimal solution of the RMABP is known to be computationally intractable. In many cases, the Whittle index policy achieves near optimal performance and can be tractably found. Nevertheless, computation of the Whittle indices requires knowledge of the transition matrices of the underlying processes, which are sometimes hidden from decision makers. In this paper, we take first steps towards a tractable and efficient reinforcement learning algorithm for controlling such a system. We setup parallel Q-learning recursions, with each recursion mapping to individual possible values of the Whittle index. We then update these recursions as we control the system, learning an approximation of the Whittle index as time evolves. Tested on several examples, our control outperforms naive priority allocations and nears the performance of the fully-informed Whittle index policy.

15:45-17:45 FC1.5

Distributed Nonlinear Model Predictive Control and Reinforcement Learning, pp. 255-257

Saeed, Ifrah — The University of Melbourne

Alpcan, Tansu — The University of Melbourne

Erfani, Sarah Monazam — University of Melbourne

Yilmaz, M. Berkay — Akdeniz University

Coordinating two or more dynamic systems such as autonomous vehicles or satellites in a distributed manner poses an important research challenge. Multiple approaches to this problem have been proposed including Nonlinear Model Predictive Control (NMPC) and its model-free counterparts in reinforcement learning (RL) literature such as Deep Q-Network (DQN). This initial study aims to compare and contrast the optimal control technique, NMPC, where the model is known, with the popular model-free RL method, DQN. Simple distributed variants of these for the specific problem of balancing and synchronising two highly unstable cart-pole systems are investigated numerically. We found that both NMPC and trained DQN work optimally under ideal model and small communication delays. While NMPC performs sub-optimally under a model-mismatch scenario, DQN performance naturally does not suffer from this. Distributed DQN needs a lot of real-world experience to be trained but once it is trained, it does not have to spend its time finding the optimal action at every time-step like NMPC. This illustrative comparison lays a foundation for hybrid approaches, which can be applied to complex multi-agent scenarios.

15:45-17:45 FC1.6

Path Planning for a Mobile Robot in Unknown Dynamic Environments Using Integrated Environment Representation and Reinforcement Learning, pp. 258-263

Zhang, Jian University of New South Wales

This study develops a new path planning method which utilizes integrated environment representation and reinforcement learning to control a mobile robot with non-holonomic constraints in unknown dynamic environments. With the control algorithm presented, no approximating the shapes of the obstacles or even any information about the obstacles' velocities is needed. Our novel approach enables to find the optimal path to the target efficiently and avoid collisions in a cluttered environment with steady and moving obstacles. We carry out extensive computer simulations to show the outstanding performance of our approach.

15:45-17:45 FC1.7

2.5D Image-Based Robotic Grasping, pp. 264-269

Song, Yaoxian Westlake University
Cheng, Chun Fudan University
Fei, Yuejiao Westlake University
Li, Xiangqing Westlake University
Liu, Qingchen Australian National University
YU, Changbin Australian National University

We consider the problem of robotic grasping by 2.5D image data sampling from a real sensor. We design an encoder-decoder neural network to predict grasping policy in real-time which enhances the robustness for the policy generation at different observation heights by fusing depth image and RGB image. We propose an open-loop algorithm to realize robotic grasp operation and evaluate our method in a physical robotic system. The result shows that our method is competitive with the state-of-the-art in grasp performance, real-time and model size. The video is available in https: //youtu.be/Wxw_r5a8qV0.

15:45-17:45 FC1.8

On Palm Vein As a Contactless Identification Technology, pp. 270-275

Marattukalam, Felix The University of Auckland
Abdulla, Waleed The University of Auckland

Palm vein biometrics has received a lot of attention in recent years. This technology offers accuracy, robustness and is contactless, which makes it a promising option for clinical applications. It uses palm vascular patterns of individuals as identification metric to match the identity. As per observations, the vein structure beneath the palm surface has a more complicated pattern as compared to the back of the palm, the fingers or any other easily accessible vein networks in the body. Thus, the palm vein can provide more features to be used for authentication. This paper highlights the performance evaluation of various approaches adopting this authentication technique. The performance evaluation is based on standard metrics such as equal error rate and false acceptance rate. We compare different techniques based on existing published research and summarize their advantages and disadvantages. We finally suggest the use of deep learning algorithms in the decision-making process which promises to be most reliable for near future applications.

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