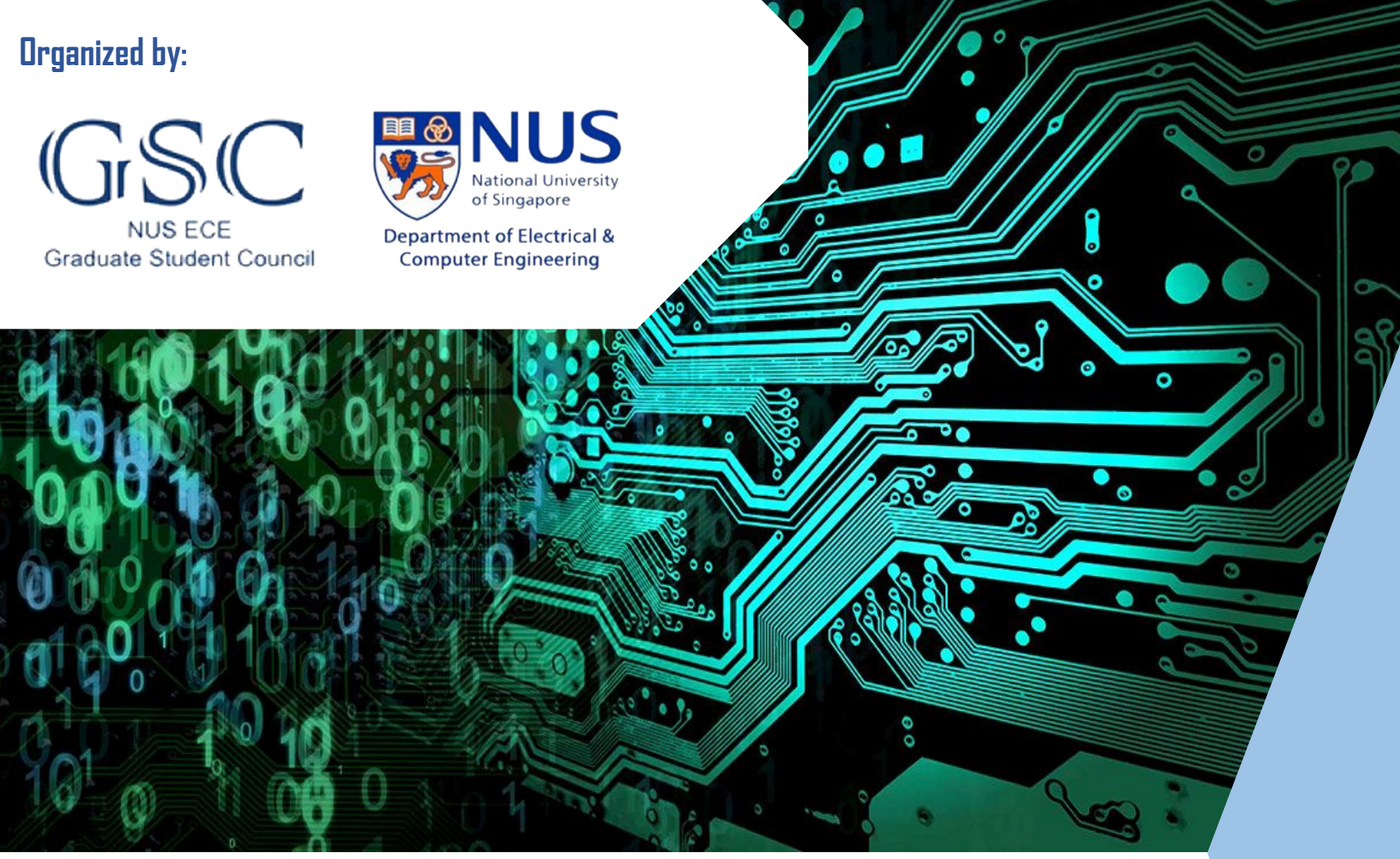
Organized by:

GSC
NUS ECE
Graduate Student Council

NUS National University of Singapore
Department of Electrical & Computer Engineering



ELECTRICAL AND COMPUTER ENGINEERING

The 1ST
NUS Circuits & AI Symposium

To promote, scale, and amplify your research through cutting-edge innovation on circuits and AI technology

Join Us!

2:00-5:00 PM, 15th Dec.
2021 Virtually on Zoom

Supported by:

IEEE SINGAPORE MTT/AP JOINT CHAPTER

NUS National University of Singapore

The MMIC Modeling and Package Laboratory

The 1st NUS Circuits & AI Student Symposium 2021 will be held on 15th December 2021 in NUS! This symposium is organized by the Graduate Student Council (GSC) of the Department of Electrical and Computer Engineering and supported by IEEE Singapore MTT/AP Chapter. The objective is to further enhance the quality of graduate seminars as well as provide a platform for undergraduates, graduates students, and faculty to exchange the latest research findings and ideas. The symposium also provides a unique networking opportunity for students to present their research work in the related area shared opinions with mentors from universities, institutes, and industries.

Organizing Committee

Yan Xu (General Chair)
Wang Jiahao (Member)
Zeng Qihang (Member)
Zhang Bo (Member)
Zhang Jingyuan (Member)

Advisory Committee

Prof. Yongxin GUO (National University of Singapore)
Asst. Prof. John S. HO (National University of Singapore)
A. Prof. Chao-Fu WANG (National University of Singapore)

Zoom Link

Testing room (2:00-5:00 PM 14th Dec.):
https://nus-sg.zoom.us/j/84487716728?pwd=MElWOXh3SlE4ZW1yZ0YxQWdsZXdmZz09
Account: 844 8771 6728, Password: 112233

Meeting room (2:00-5:00 PM 15th Dec.):
https://nus-sg.zoom.us/j/86839654613?pwd=UFNrYmh1eVJ5dGxSYmUvdzRUQmNrUT09
Account: 868 3965 4613, Password: 147258

Program Schedule

TIME		EVENT	Zoom room
14th Dec.	2:00 – 5:00 PM	Testing the zoom link quality and functions	Testing room
15th Dec.	2:00 – 2:05 PM	Opening	Meeting room
	2:05 – 4:50 PM	Technical Session	Meeting room
	4:50 – 5:00 PM	Award Announcement	Meeting room

Technical Session

	Presenters	Topics
1	**Yang Danyu** 2:05 – 2:20 PM	Compact, Surface-Mountable, Shielded and Multilayer Dual-Band Filter
2	**Hao Zelin** 2:20 – 2:35 PM	Radar SLAM for Outdoor Environment
3	**Wang Qinyi** 2:35 – 2:50 PM	Speech-and-Text Decoder: Leverage External Text for Transformer-based Speech Recognition Model
4	**Yang Yuanbo** 2:50 – 3:05 PM	Capsule Endoscopy AI-Aided Diagnosis: Object Detection
5	**Wang Jianze** 3:05 – 3:20 PM	Memtransistor Array Modelling for Nonvolatile Memory and Neural Network
6	**Zhang Jingyuan** 3:20 – 3:35 PM	High Efficiency Ku-Band 13 W GaN HEMT HPA
7	**Santos Rochelle Xenia Mendoza** 3:35 – 3:50 PM	Enhancing BLE-based Indoor Localization via Machine Learning
8	**Zhao Siyuan** 3:50 – 4:05 PM	Radar SLAM
9	**Chen Fan** 4:05 – 4:20 PM	Coil design considerations for transcranial magnetic stimulation (TMS)
10	**Zheng Zhi** 4:20 – 4:35 PM	Non-Contact Vital Signs Estimation Based on the Fusion of Radar and Camera
11	**Li Huagen** 4:35 – 4:50 PM	Adaptive background upating twisted thermal zero-index meta-device

Instructions for Speakers

(1) For each presentation slot: 15 minutes (12 minutes for presentation and 3 minutes for Q&A). The chair will remind you 2 minutes before the presentation time ends.

(2) Your presentation will be followed by Question & Answer (Q&A) session. The length of your Q&A session will be determined by the chair, depending on the progress of the presentations in the session. Generally, the Q&A session for each paper will not exceed 3 minutes.

(3) You may find your presentation section, date & time in the Program Book.

(4) Please prepare your presentation materials for the presentation. We prefer using Microsoft PowerPoint or Adobe Acrobat as the presentation tool. Collection of presentation materials is needed.

(5) The formal meeting is held via Zoom on 2:00-5:00 PM, 15th Dec. You can come to the test room at 2:00-5:00 PM on 14th Dec. to test the screen share quality and functions of your software and internet connection.

Compact, Surface-Mountable, Shielded and Multilayer Dual-Band Filter

PRESENTER: **Yang Danyu**

Abstract:

A very compact, surface-mountable, shielded and multilayer dual-band filter is proposed. Compactness is achieved by using quarter-wavelength (λ/4) stepped impedance resonators (SIRs) which are shielded inside a substrate integrated waveguide (SIW) cavity. The presence of metal housing reduces the radiation loss and enhances the electromagnetic compatibility. Two SIRs are series connected and grounded with a common metallized via-hole leading to a second-order filtering response. Based on the multilayer printed circuit board (PCB) technology, dual-band operation is achieved by vertically stacking different-size resonators to fully utilize the space. Strip lines in the middle layer are used to feed the SIRs. The source-to-load coupling is introduced to generate transmission zeros (TZs) on each side of the passbands. The lower and upper passbands are relatively independent due to the good isolation by middle ground layer, resulting in great design freedom. The measured results agree well with the full-wave simulation.

Radar SLAM for Outdoor Environment

PRESENTER: **Hao Zelin**

Abstract:

In the last decade, many Simultaneous Localization and Mapping (SLAM) algorithms based on various sensors have been proposed, among which the more typical ones are using lidar and camera as front-end sensors. However, in outdoor environments, these optical-based sensors are limited in the face of extreme weather like rain, snow and fog. Radar sensors that can work in various weathers have been adopted in Autonomous driving and road monitoring. The use of radar sensors for SLAM in large-scale outdoor environments under extreme weather conditions has a promising future.

Speech-and-Text Decoder: Leverage External Text for Transformer-based Speech Recognition Model

PRESENTER: **Wang Qinyi**

Abstract:

With the introduction of Transformer, speech recognition has seen significant improvement. Transformer-based automatic speech recognition (ASR) systems rely on the self-attention mechanism to learn representations from paired speech-transcriptions. However, transcribed speech is much more arduous to acquire than stand-alone text. How to Leverage external text data for end-to-end encoder-decoder speech recognition models has remained an active research area.

Previous solutions to this problem include utilizing knowledge from extrinsic language models during the model training or decoding stage, back-translating text into speech as data augmentation, and pretraining the network with a large text corpus. These techniques either undermine the idea of "end-to-end" network by relying on external language model (LM) modules or require sophisticated training procedures.

In this talk, we address these limitations by introducing a Transformer decoder architecture with an internal LM module that allows the system to use both paired acoustic-text data and unpaired text data for training. We also investigate the multi-objective learning framework and analyze training schemes for efficiently utilizing non-parallel text data in addition to parallel speech-text data.

Capsule Endoscopy AI-Aided Diagnosis: Object Detection

PRESENTER: **Yang Yuanbo**

Abstract:

The task of Object Detection is to find all the objects of interest in the image, and to determine their categories and positions, which is one of the core problems in the field of computer vision. Since various objects have different appearances, shapes and postures, coupled with the interference of factors such as illumination and occlusion during imaging, object detection has always been the most challenging problem in the field of computer vision. This project aims to using bounding box to locate and classify the lesions in the images of Capsule endoscope. Consequently we can help doctors make a diagnosis faster and improve the efficiency of medical treatment.

Memtransistor Array Modelling for Nonvolatile Memory and Neural Network

PRESENTER: **Wang Jianze**

Abstract:

Emerging memory devices like STT-MRAM and ReRAM have drawn increasing attention for memory usage and neural network accelerators as they possess intrinsic nonvolatile characteristics and synaptic-like behaviors. However, these devices are 2-terminal devices which require an additional selector for memory usage to prevent sneak path current. Thus, multi-terminal resistive based memory device is proposed, memtransistor, which has a field effect geometry and consists of a top/bottom gate for further control. No array level circuit model for memtransistor has been reported yet and further applications like memtransistor based neural network accelerating can be explored.

High Efficiency Ku-Band 13 W GaN HEMT HPA

PRESENTER: **Zhang Jingyuan**

Abstract:

Due to the increasing demand for high-speed, low-latency wireless communication, the performance requirements on RF front ends (RFFEs) have been stricter than before. Great interest has been attracted in designing high-performance RFFE subcircuits such as low noise amplifier (LNA) and power amplifier (PA). As a key component in an RF transceiver, the efficiency of the power amplifier determines the overall power consumption of the system.

This paper reports on a Ku-band high-power amplifier (HPA) monolithic microwave integrated circuit (MMIC) on 150-nm GaN-SiC high electron mobility transistor (HEMT) process, which exhibits high output power (13 W Psat) and high efficiency (45 % peak PAE) under pulse simulation with 100 μs period and 10 % duty cycle. By employing wideband matching networks (MNs), the proposed HPA achieves 39.2 ~ 41.2 dBm Pout and 35.7% ~ 45.4% PAE from 14.0 to 18.0 GHz. Power gain exceeds 17 dB in the operating band. The HPA chip dimensions are 2.55 mm by 1.3 mm. These results provide the potential for this HPA to be applied in satellite communications (SATCOM).

Enhancing BLE-based Indoor Localization via Machine Learning

PRESENTER: **Santos Rochelle Xenia Mendoza**

Abstract:

Indoor Positioning Systems (IPS) utilizing Bluetooth Low Energy (BLE) technology have garnered much attention due to their relative low cost and compatibility with currently existing wireless infrastructure and user devices. Theoretically, good localization accuracy can be ensured by deploying beacons with sufficient density and careful design in the areas of interest. However, in practical scenarios, performance is often degraded due to the system's inherent vulnerability to multipath effects, electromagnetic interference, and clutter. This uncertainty coupled with installation and maintenance costs has so far hindered system adoption. The successful application of Machine Learning (ML) based AI techniques in other areas has also sparked an interest in using them to improve the accuracy and robustness of IPS. ML solutions have been proposed as augmentations, extensions, or replacements to existing positioning engines. For BLE-based IPS, ML models can aid triangulation by identifying and discarding attenuated signals, refine calculated position estimates by reducing jumping phenomena, and track targets in areas with insufficient or tenuous Bluetooth coverage. These measures can potentially produce more accurate position estimates, reduce hardware infrastructure, and automatically introduce system robustness that is typically achieved with manual fine-tuning in traditional localization systems.

Radar SLAM

PRESENTER: **Zhao Siyuan**

Abstract:

Simultaneous localization and mapping (SLAM) is the computational problems of constructing or updating a map of an unknown environment while simultaneously keeping track of an device location within it. The current mature SLAM solution is to use LiDAR and monocular camera. This will bring about unexpected problems. However, camera and LiDAR based SLAM systems can be fragile when facing challenging illumination or weather conditions which degrade their imagery and point cloud data. Radar, whose operating electromagnetic spectrum is less affected by environmental changes, is promising although its distinct sensing geometry and noise characteristics bring open challenges when being exploited for SLAM. We use TI millimeter wave 4D imaging radar which has very high azimuth and elevation resolution to realize a high accuracy SLAM.

Coil design considerations for transcranial magnetic stimulation (TMS)

PRESENTER: **Chen Fan**

Abstract:

Transcranial magnetic stimulation (TMS) is a non-invasive brain stimulation technique which applies a brief current of very high intensity, usually several thousands of amps, in a copper wire coil and produces a magnetic field that penetrates the skull and induces a current flow in the underlying neuronal tissue. However, there are several important problems in the current coil designs for TMS.

1. The existing coil designs suffer from electric field depth-focality tradeoff.
2. Current-stage coil design research of TMS generally uses simplified head models (e. g. homogeneous spherical model), neglecting the inhomogeneity of human brain and not accurate enough.
3. Different applications require different stimulation patterns in terms of depth and focality, where a single coil design may not suffice.
4. The orientation of coils in most TMS experiments still requires manual adjustment which may be both time consuming and inaccurate.

Therefore, novel coil designs based on realistic head models which perform better in terms of depth-focality tradeoff, tunable in stimulation patterns (e. g. E field distributions) and orientation-compatible should be studied.

Non-Contact Vital Signs Estimation Based on the Fusion of Radar and Camera

PRESENTER: **Zheng Zhi**

Abstract:

Vital signs such as heart rate, respiration rate, and blood pressure are currently measured using contact probes or cuffs, causing inconvenience and discomfort to the users. In this work, we proposed a non-contact vital signs estimation method based on the fusion of radar and camera. Within our approach, the microwave radar captures the chest pulse while the camera collects the palm pulse. Plus, we utilize an artificial neural network (ANN) with the fusion of radar and camera for estimating blood pressure. Applying this approach to the experiment, the results show that the proposed method can estimate the subject's vital signs via non-contact.

Adaptive background upating twisted thermal zero-index meta-device

PRESENTER: **Li Huagen**

Abstract:

Thermal metamaterials or metadevices with a convective component which can actively tune heat flux at will have demonstrated the potential application advantages in transforming thermodynamics. However, the continuous energy input is always needed to keep the rotational thermal operation and the in-plane thermal modulation is usually used if some convective parts are introduced. Recently, the energy conservation technology and the out-plane modulation are both quite hot, especially the precise control of the twisted bilayers in photonics. Thereby, we propose an adaptive background updating twisted thermal near-zero energy input metadevice, flexibly modulating the heat flux via the change of the twisted angle which is one of the so-called out-plane thermal operations. Specifically, through the symmetric twist operation of the upper and under anisotropic layer on the heat flow direction, we can quickly realize an adaptive background updating thermal near-zero energy input cloak. In other words, when background updates, we just need to quickly modulate the twisted angle rather than renew component or rotate some parts with continuous energy input to realize the thermal cloak function again, which is quite more feasible and near zero energy consumption for the rapid deployment of metadevice. It opens more out-plane thermal modulation methods for designing novel thermal near-zero energy input metadevices beyond just cloaking.