

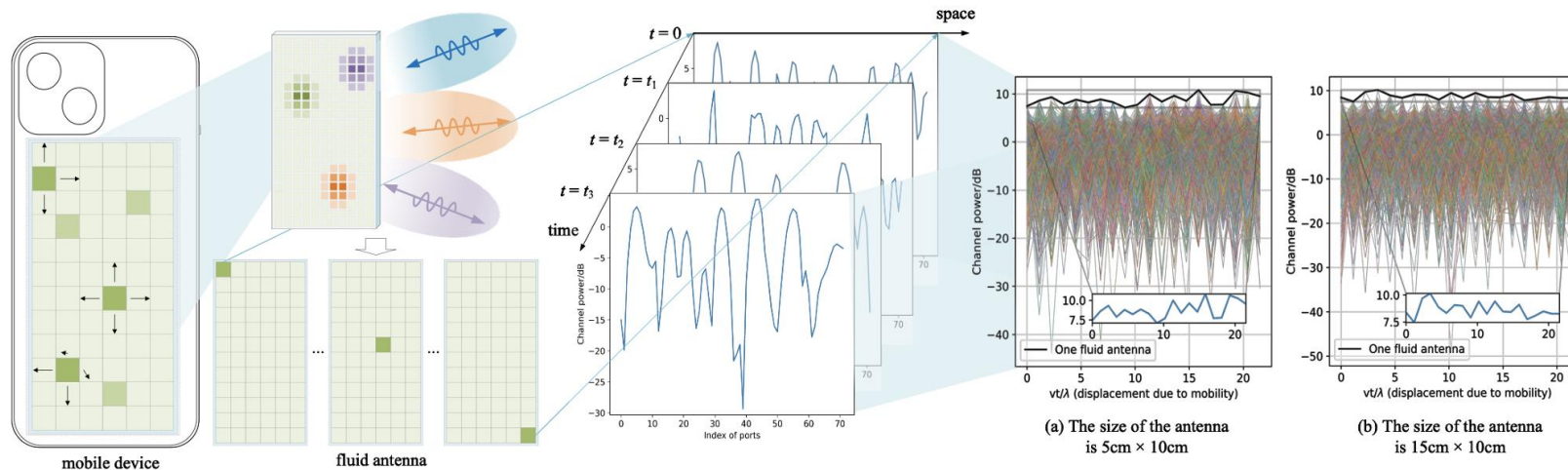
TCCN Special Interest Group (SIG) on Fluid Antenna System (FAS)

Kai-Kit Wong (Chair)

University College London (UCL)
London, United Kingdom

Fluid Antenna System (FAS)

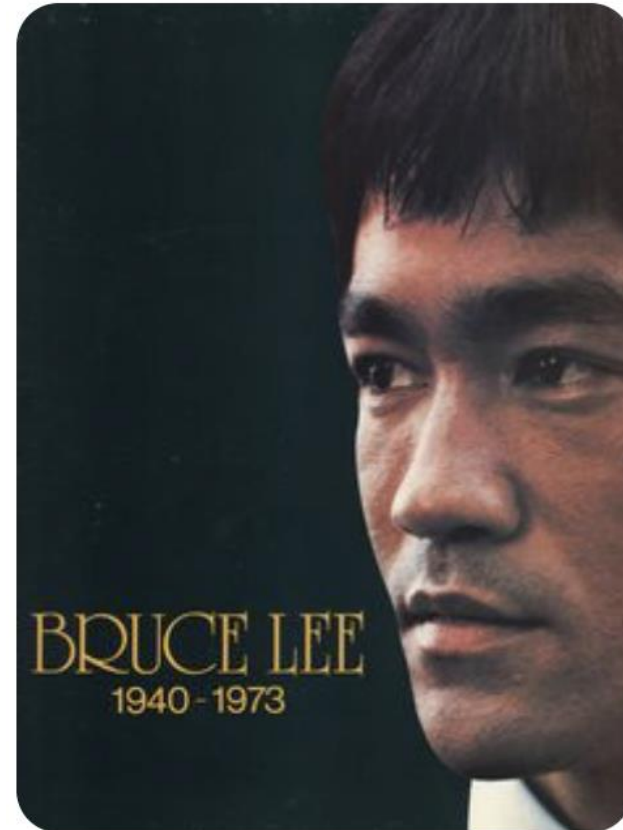
- A new breed of reconfigurable antennas
- Represents **shape-flexible position-flexible** antenna systems
- Provides a **new degree of freedom** in the physical layer
- The term “**fluid**” is to highlight the **flexible nature** of such antennas



An Inspiration from Bruce Lee

Be Water, My Antenna!

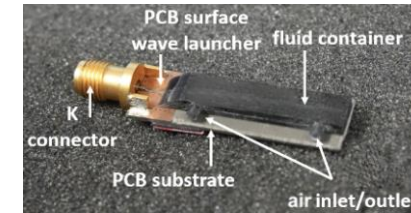
1. K. K. Wong, K.-F. Tong, Y. Zhang, and Z. Zheng, "**Fluid antenna system for 6G: When Bruce Lee inspires wireless communications**," [Electronics Letters](#), vol. 56, no. 24, pp. 1288-1290, **November 2020**.
2. K. K. Wong, A. Shojaeifard, K. F. Tong, and Y. Zhang, "**Performance limits of fluid antenna systems**," [IEEE Communications Letters](#), vol. 24, no. 11, pp. 2469-2472, **November 2020**.
3. K. K. Wong, A. Shojaeifard, K. F. Tong, and Y. Zhang, "**Fluid antenna systems**," [IEEE Transactions on Wireless Communications](#), vol. 20, no. 3, pp. 1950-1962, March 2021.
4. K. K. Wong, K.-F. Tong, Y. Shen, Y. Chen, and Y. Zhang, "**Bruce Lee-inspired fluid antenna system: Six research topics and the potentials for 6G**," [Frontiers in Communications and Networking](#), vol. 3, no. 853416, March 2022.
5. W. K. New *et al.*, "**A tutorial on fluid antenna system for 6G networks: Encompassing communication theory, optimization methods and hardware designs**," [IEEE Communications Surveys and Tutorials](#), 2024.



FAS is REAL

- Liquid-based surface-wave enabled FAS

1. Y. Shen *et al.*, "**Design and implementation of mmWave surface wave enabled fluid antennas and experimental results for fluid antenna multiple access**," [Online] [arXiv:2405.09663](https://arxiv.org/abs/2405.09663), May 2024.



Prof. Steve Hang Wong
CityU



Prof. Kenneth Tong
UCL

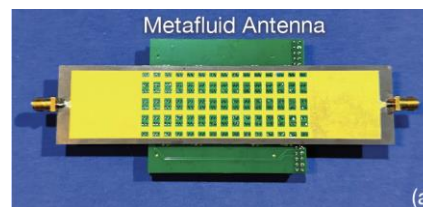
- Pixel reconfigurable antenna-based FAS

2. J. Zhang *et al.*, "**A novel pixel-based reconfigurable antenna applied in fluid antenna systems with high switching speed**," IEEE Open Journal of Antennas and Propagation, DOI:10.1109/OJAP.2024.3489215, 2024.



Prof. Ross Murch
HKUST

- Meta-material FAS



Prof. Baiyang Liu
Shenzhen Tech U



Prof. Steve Wong
CityU



Prof. Kenneth Tong
UCL

Numerous Applications



Applications

- CR,
- MEC
- PLS
- AirComp
- SWIPT
- FD
- IM
- ...

A Tutorial on Fluid Antenna System for 6G Networks: Encompassing Communication Theory, Optimization Methods and Hardware Designs

Wee Kiat New, *Member, IEEE*, Kai-Kit Wong, *Fellow, IEEE*, Hao Xu, *Member, IEEE*,
Chao Wang, *Senior Member, IEEE*, Farshad Rostami Ghadi, *Member, IEEE*, Jichen Zhang, *Graduate Student Member, IEEE*, Junhui Rao, *Graduate Student Member, IEEE*, Ross Murch, *Fellow, IEEE*,
Pablo Ramírez-Espinoza, David Morales-Jimenez, *Senior Member, IEEE*,
Chan-Byoung Chae, *Fellow, IEEE*, and Kin-Fai Tong, *Fellow, IEEE*

Abstract—The advent of the sixth-generation (6G) networks presents another round of revolution for the mobile communication landscape, promising an immersive experience, robust reliability, minimal latency, extreme connectivity, ubiquitous coverage, and capabilities beyond communication, including intelligence and sensing. To achieve these ambitious goals, it is apparent that 6G networks need to incorporate the state-of-the-art technologies. One of the technologies that has garnered rising interest is fluid antenna system (FAS) which represents any software-controllable

of freedom (dof) to harness diversity and multiplexing gains. In this paper, we provide a comprehensive tutorial, covering channel modeling, signal processing and estimation methods, information-theoretic insights, new multiple access techniques, and hardware designs. Moreover, we delineate the challenges of FAS and explore the potential of using FAS to improve the performance of other contemporary technologies. By providing insights and guidance, this tutorial paper serves to inspire researchers to explore new horizons and fully unleash the potential of FAS.

Recent Activities on FAS

- 2023 IEEE MICC [Tutorial](#) in Kuala Lumpur, Malaysia
- 2024 IEEE ICC [Workshop](#) in Denver, USA
- 2024 IEEE GLOBECOM [Workshop](#) in Cape Town, South Africa
- 2025 IEEE ICC [Workshop](#) in Montreal, Canada
- JSAC [Special Issue](#) on [Fluid Antenna System and Other Next-Generation Reconfigurable Antenna Systems for Wireless Communications](#) ([deadline 15 Feb. 2025](#))
- WCM [Special Issue](#) on [Movable and Reconfigurable Antennas-Empowered Wireless Networks](#) ([deadline 1 Jun. 2025](#))
- ...

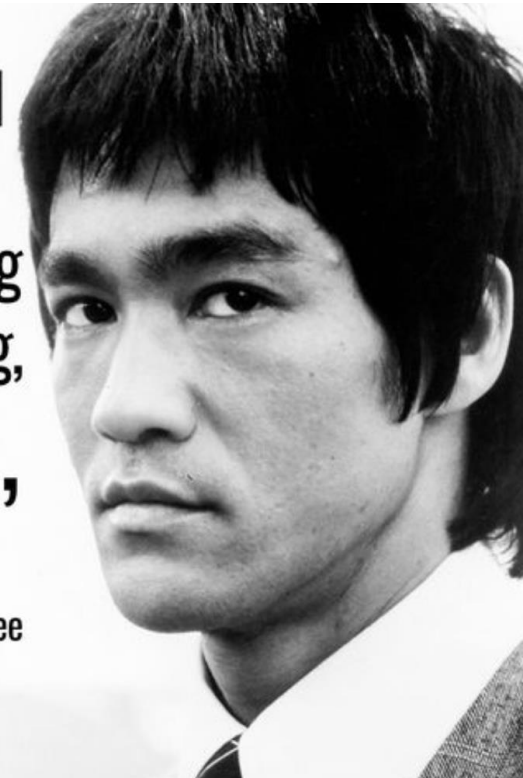
Some Resources

- A single **webpage** on the TCCN website has been drafted
☞ <https://sites.google.com/view/ieee-comsoc-tccn-sig-fas/Home>
- A **website** for SIG on FAS is under preparation
☞ <https://www.ee.ucl.ac.uk/fluid-antenna-systems/HOME.html>
- A **YouTube** channel for FAS
☞ <https://www.youtube.com/@FluidAntennaSystem>
- A **WeChat Group** for the FAS community:



“If you spend
too much
time thinking
about a thing,
you’ll never
get it done.”

Bruce Lee





IEEE Communications Society

29,549 followers



ComSoc Technology News – Podcast Episode12: Fluid Antennas for 6G and Beyond



 <https://www.youtube.com/watch?v=TT80gwgu4Zg&t=15s>

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