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Edinburgh, Scotland
UK EH14 4AS
+44 131 449 5111

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Fully funded PhD Studentship:

**Advanced Radio Frequency Frontend for Enhanced
Wireless Connectivity**

Microwaves and Antenna Engineering Group

<https://microwaves.site.hw.ac.uk>

PhD Studentship

In Microwave and Antenna Engineering Group
Heriot-Watt University, Edinburgh, Scotland, UK, EH14 4AS

Advanced Radio Frequency Frontend for Enhanced Wireless Connectivity

Project Description

The pursuit towards higher spectral efficiency in mobile broadband wireless networks has significantly enhanced the performance of wireless systems through advancements such as massive and cell-free MIMO, sophisticated modulation and coding schemes, and advanced signal processing techniques. Recently, the focus has shifted towards leveraging artificial reflecting surfaces to create favourable wireless channels, thereby unlocking the full potential of the electromagnetic spectrum. Wireless channel manipulation is achieved using so-called Reconfigurable Intelligent Surfaces (RIS), which typically comprise a periodic arrangement of thousands of centrally controlled unit cells. In its current form, these cells need to be globally (on the RIS) reconfigured to reflect incoming radio frequency (RF) wavefronts by varying the phase shifts of reflection coefficients of each RIS unit cell to redirect the incoming wireless signals towards wireless users who otherwise are difficult to be served or poorly connected.

In current practice, the RIS architectures require a central digital control unit, which on one hand requires a cabled feedback link to the Base Transmitter Station (BTS) to assist tedious and iterative channel estimation, while on the other hand needs to coordinate the reconfiguration of thousands of RIS unit cells. All these impose significant challenges on the RIS design (e.g., high hardware complexity, huge power consumption), deployment (e.g., cabled feedback link), and usage (e.g., inapplicable in fast-fading channels due to high latency). At current state of the art these factors largely counteract the benefits these surfaces promise.

Marking a fundamental departure from existing RIS architectures, the aim of this PhD project is to establish the foundation of Self-Programming Autonomous Reconfigurable Surfaces comprised of unit cells capable of autonomously, independently, and in real-time configuring their reflection characteristics such that a global channel state optimum is achieved through the cumulative effect of the scattering produced by each unit cell. This modular design topology for the first time exploits low-complexity analogue-dominant circuits and subsequent lightweight mixed signal processing to establish local time, frequency, and phase references in the vicinity, which, in the absence of global control and coordination, are sufficient for the unit cells to compensate channel propagation phase or delay, essentially enabling beamforming, in real-time towards the users to be serviced. The specific research objectives are:

- 1) Establish a simulation platform to gain quantitative insights into the targeted design specifications and performance benefits in various typical application scenarios.
- 2) Design low-complexity analogue RF and Intermediate Frequency (IF) circuitry that can real-time sense, control, and compensate the channel delay through an incoming multi-frequency waveform.
- 3) Prototype industry relevant proof-of-concept demonstrators to showcase the disruptive capability involving 5G New Radio (NR) physical-layer waveforms, multi-user data throughputs and information transmission security.

Duration: 42 Months

Scholarship: ~£22,000 annual stipend (tax-free) plus tuition fees waived

Deadline: 20/03/2026 - 12:00

Supervision Team:

To apply please send your motivation letter, CV, and recommendation letters (optional) to yuan.ding@hw.ac.uk.

Candidate:

MSc degree or equivalent in electrical engineering with a focus on RF/microwave engineering, electromagnetics, antenna theory, and communication theory.