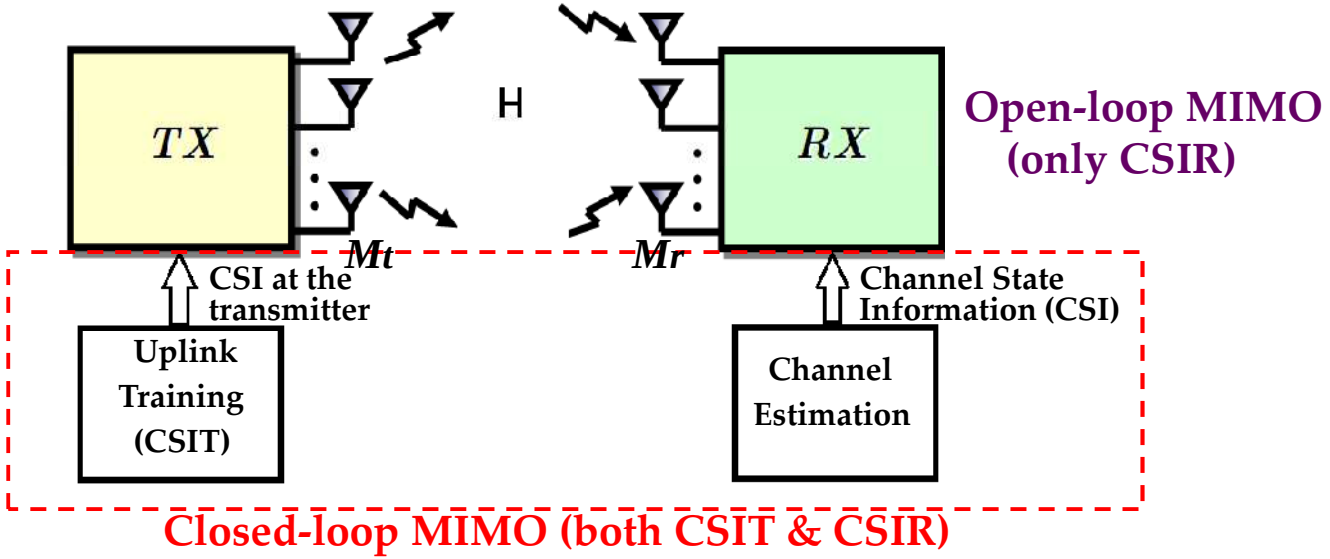
A High Performance Closed-Loop MIMO Communications with Ultra Low Complexity Handset

Yu-Han Yuan, Wei-Ming Chen and Hsi-Pin Ma

Department of Electrical Engineering,
National Tsing Hua University,
Hsinchu, Taiwan

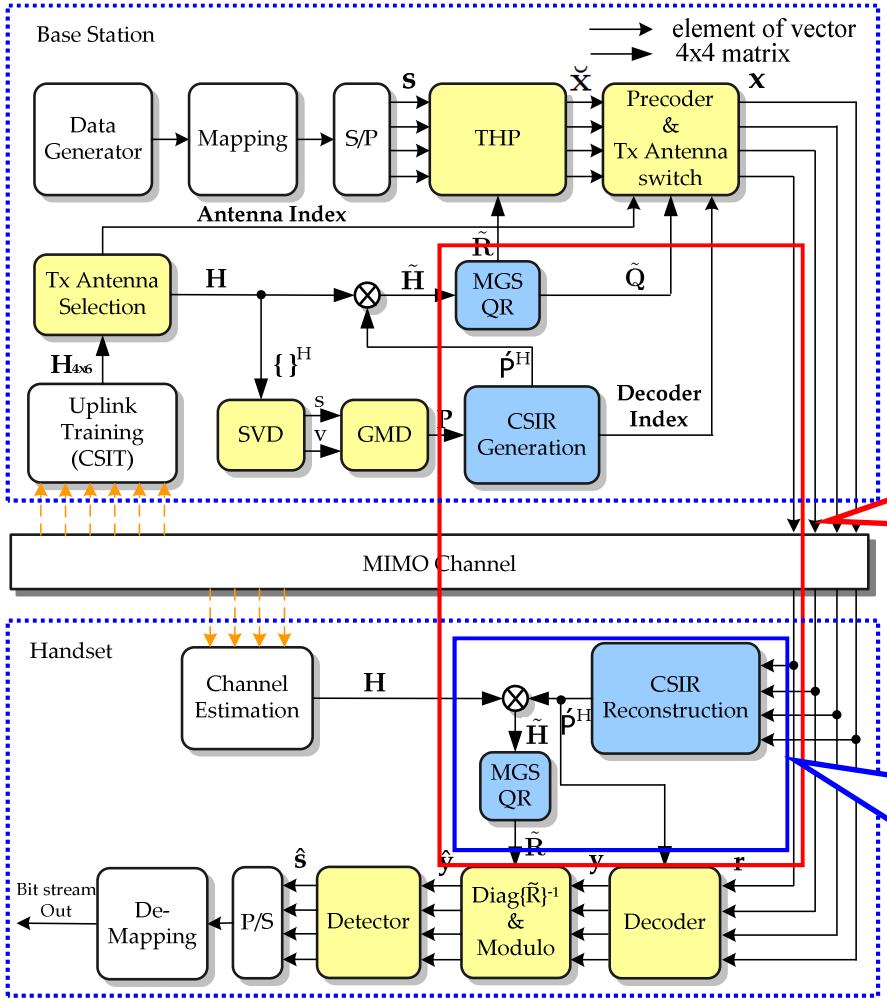
Motivation

- Joint Transceiver Design for Closed-Loop MIMO
  - TX can take advantage of CSI to apply the advanced processing to enhance the performance of communications and potentially simplify the receiver architecture.
  - Target
    - High performance
    - Low complexity handset



Architecture of the Proposed Transceiver

- An efficient and practicable MIMO transceiver in which transmitter antenna selection is applied to geometric mean decomposition (GMD) which is combined with Tomlinson-Harashima Precoder (THP) in TDD system is implemented.



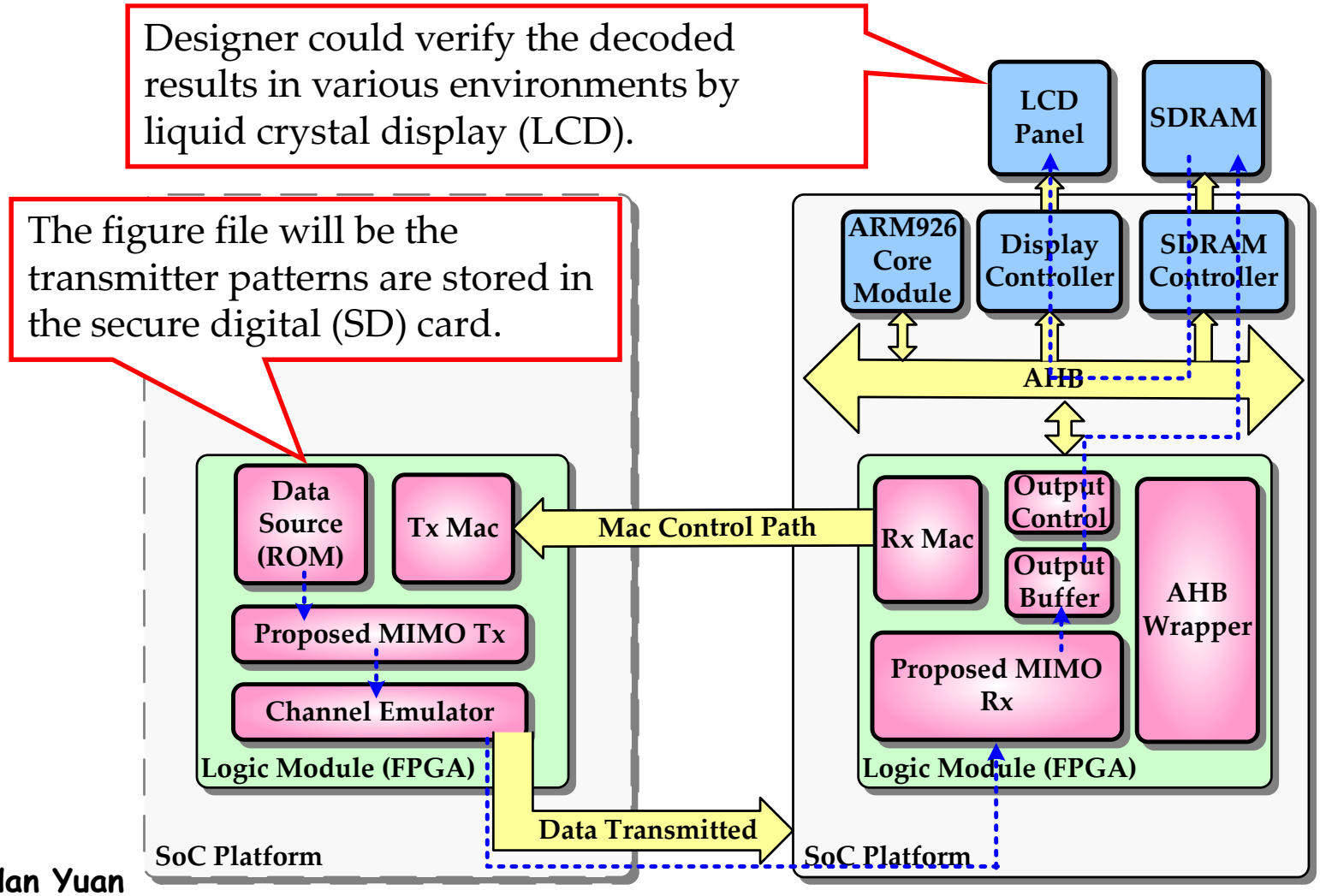
Mode	TDD
Channel Model	i.i.d. Rayleigh flat fading
Antenna Selection	4 Tx ant. from 6 Tx ant.
Spatial Multiplexing	4x4
Modulation	QPSK, 16QAM, 64QAM

In order to save GMD computation at the handset, we take the decoder quantization and reconstruction into consideration.

Compared with the GMD scheme, the complexity is 60% reduction at the handset.

Transmission Flow

- A MIMO joint transceiver is implemented on a SoC platform which is realized to do the hardware/software (HW/SW) co-verification strategy to debug the proposed architecture.

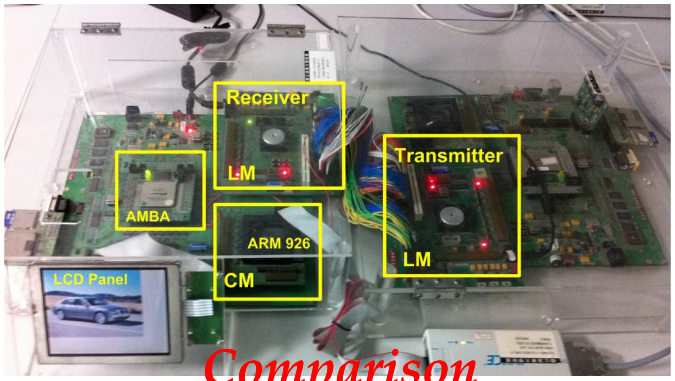


Implementation Results

Specification

Application	-WLAN -DSL Systems
Mode	TDD
Channel Condition	Rayleigh i.i.d. fading MIMO channel & Quasi-stationary
Tx. Antenna Selection	4 Tx ant. from 6 Tx ant.
Support Modulation Type	QPSK 16-QAM 64-QAM
Code book Size	Unit 4-vector with 64 entries
Maximum clock freq.	10 MHz (SoC Platform)
Maximum throughput	16 Mbps (SoC Platform)
Equivalent Gate Count (Tx/Rx)	276,768 / 109,101

Photograph of the SoC Platform



Emulation Results


(a) 20dB (b) 30dB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Comparison

Complexity comparison for diff. # of antenna

Handset	Proposed Work		GMD-THP [3]	
Computation	Complex Multiplication	Complex Addition	Complex Multiplication	Complex Addition
Mt=Mr=2	16	7	67	57
Mt=Mr=3	54	33	183	158
Mt=Mr=4	128	90	354	308
Mt=Mr=5	250	190	586	512
Mt=Mr=6	432	345	885	775
Mt=Mr=7	686	567	1257	1102

Features

- An efficient and practicable MIMO transceiver in which transmitter antenna selection is applied to GMD-THP algorithm in TDD system is implemented.
- The proposed work can achieve about 7dB SNR improvement over the open-loop VBLAST counterparts even about 2dB SNR better than ML at BER=10^{-2}.
- Compared with the GMD-THP scheme, the complexity is 60% reduction at the handset.
- Full implementation and practical SoC platform emulation (hardware/software co-verification).