應用 EMD自身呼吸消除技術以提升混合 FMCW-CW雷達架構之心跳生理訊號準確度研究

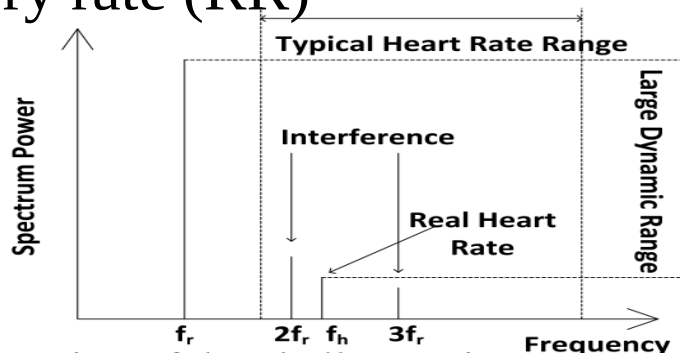
Intrinsic Respiration Calibration Technique Based on EMD to Enhance Accuracy of Heartbeat Signal Contrast in a Hybrid FMCW-CW Radar System

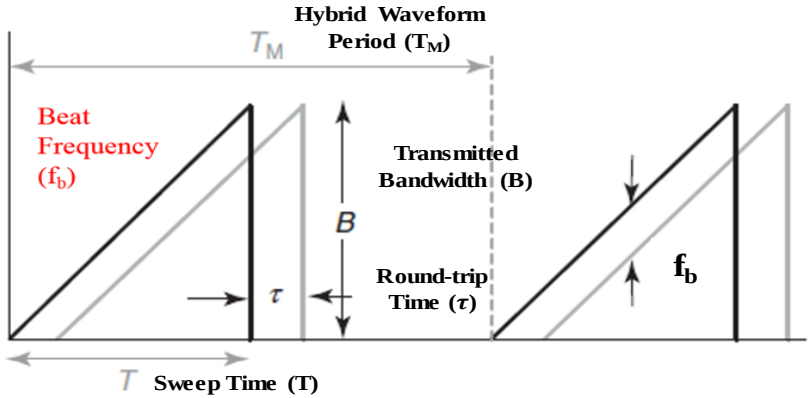
國立成功大學 電機工程研究所 儀器系統與晶片組
無線創新系統電磁應用實驗室 (WISE Lab)

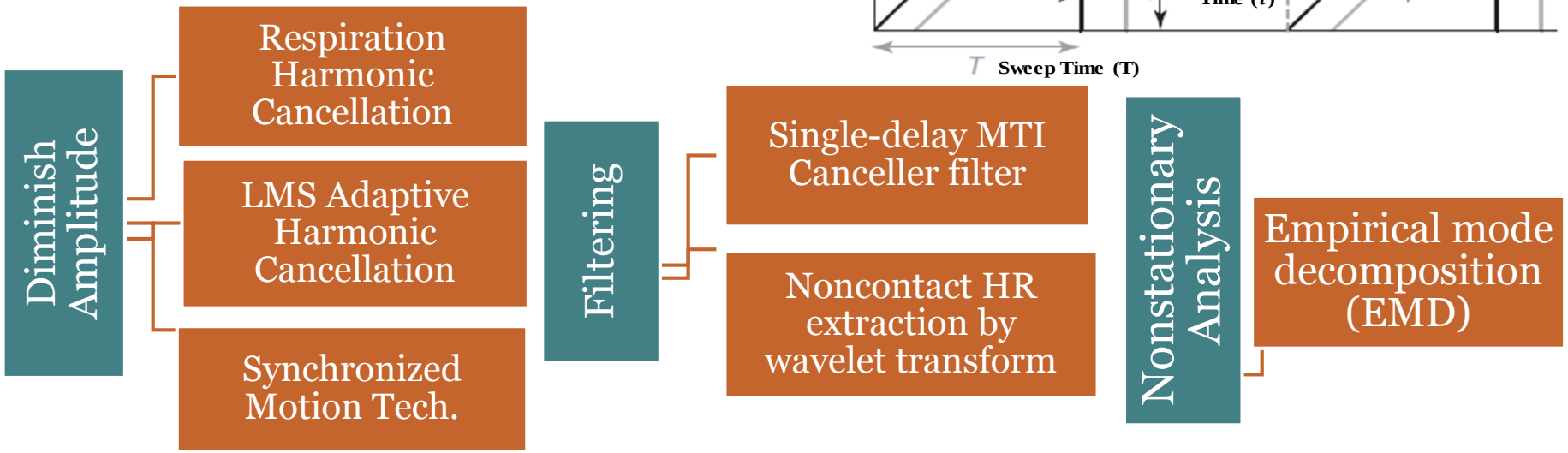
Advisor: 楊慶隆 教授 **Chin-Lung Yang**
Student: 吳東霖 **Tung-Lin Wu**

Literature Review & Objective

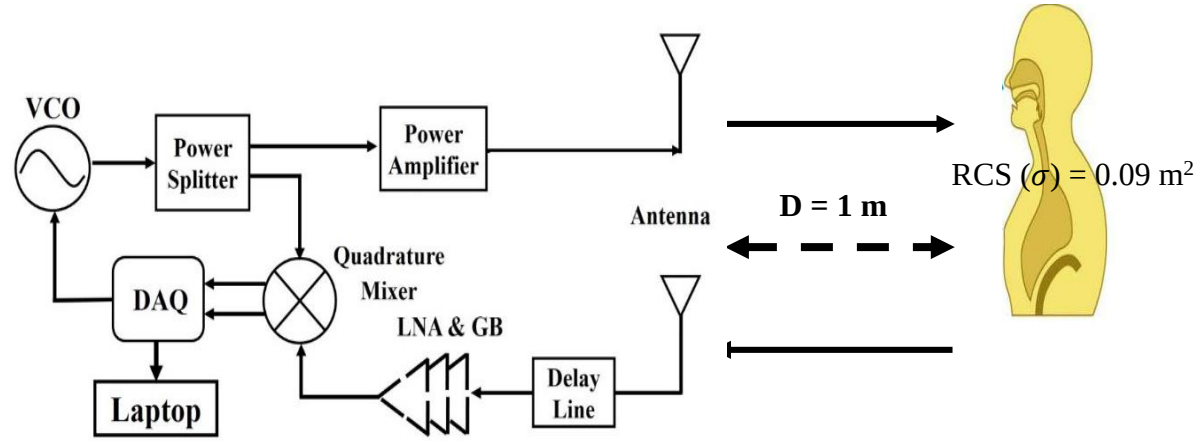
- Separate heartbeat rate (HR) and respiratory rate (RR)
  - RR power is 2-3 orders higher than HR
- Obtain vital sign and absolute range information simultaneously
  - Hybrid radar system (FMCW+CW)
  - Range distance : $R = \frac{c}{2} \times \frac{T}{B} \times f_b$
- Extracted respiration calibration by EMD-based method to enhance SNR of HR

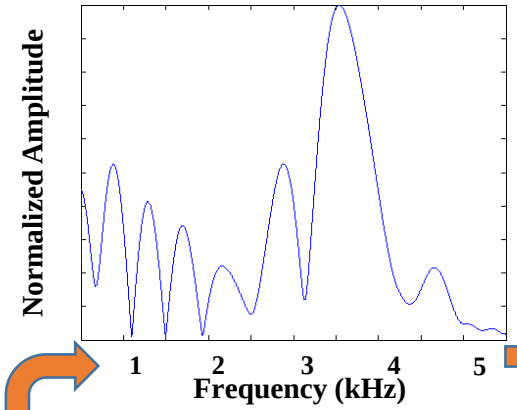




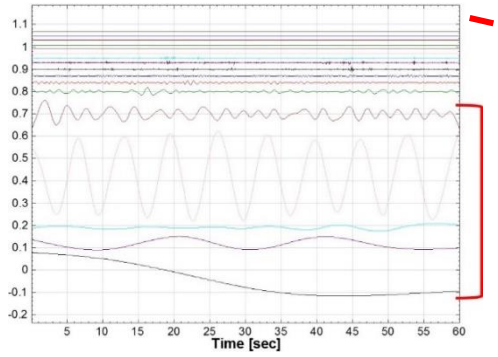


Hybrid Radar System Structure

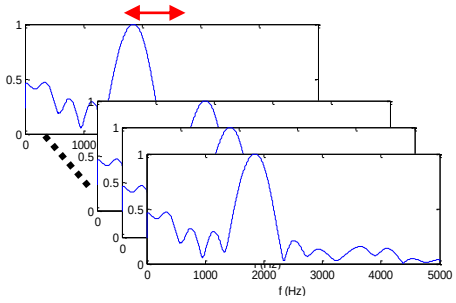


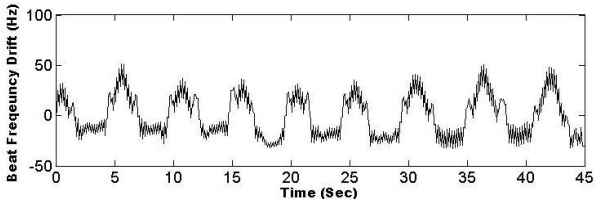


Step 1



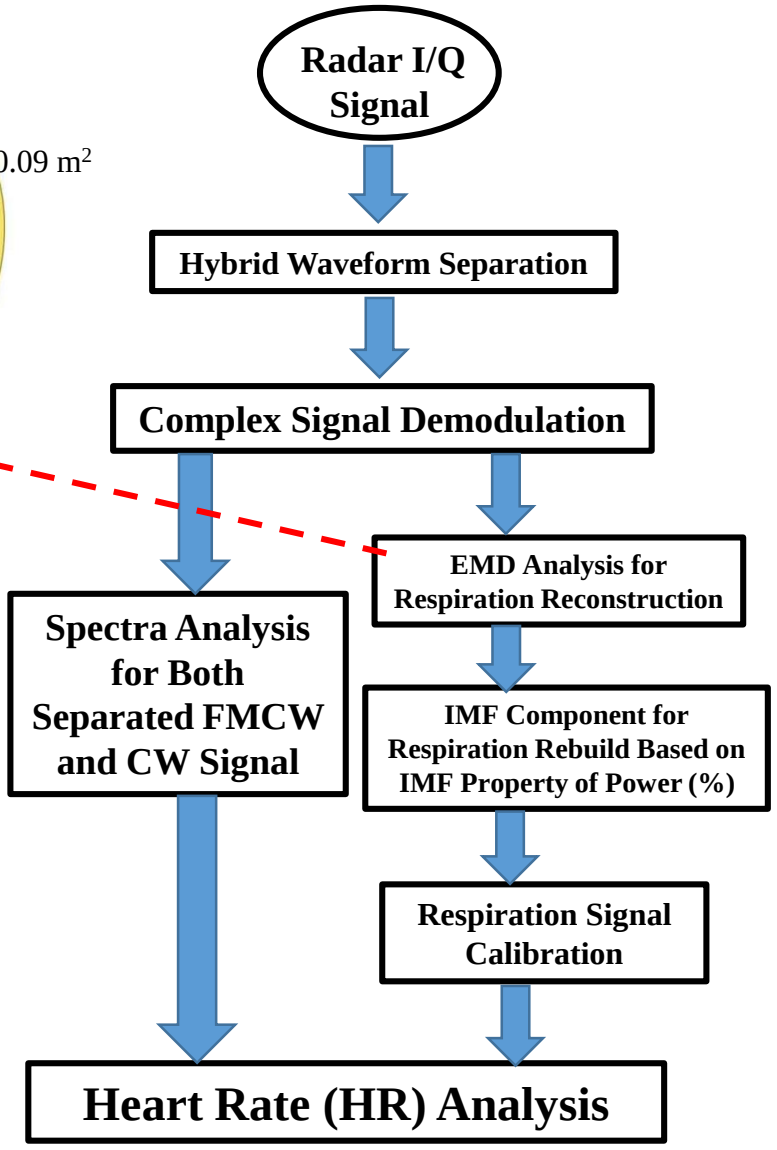
Step 2



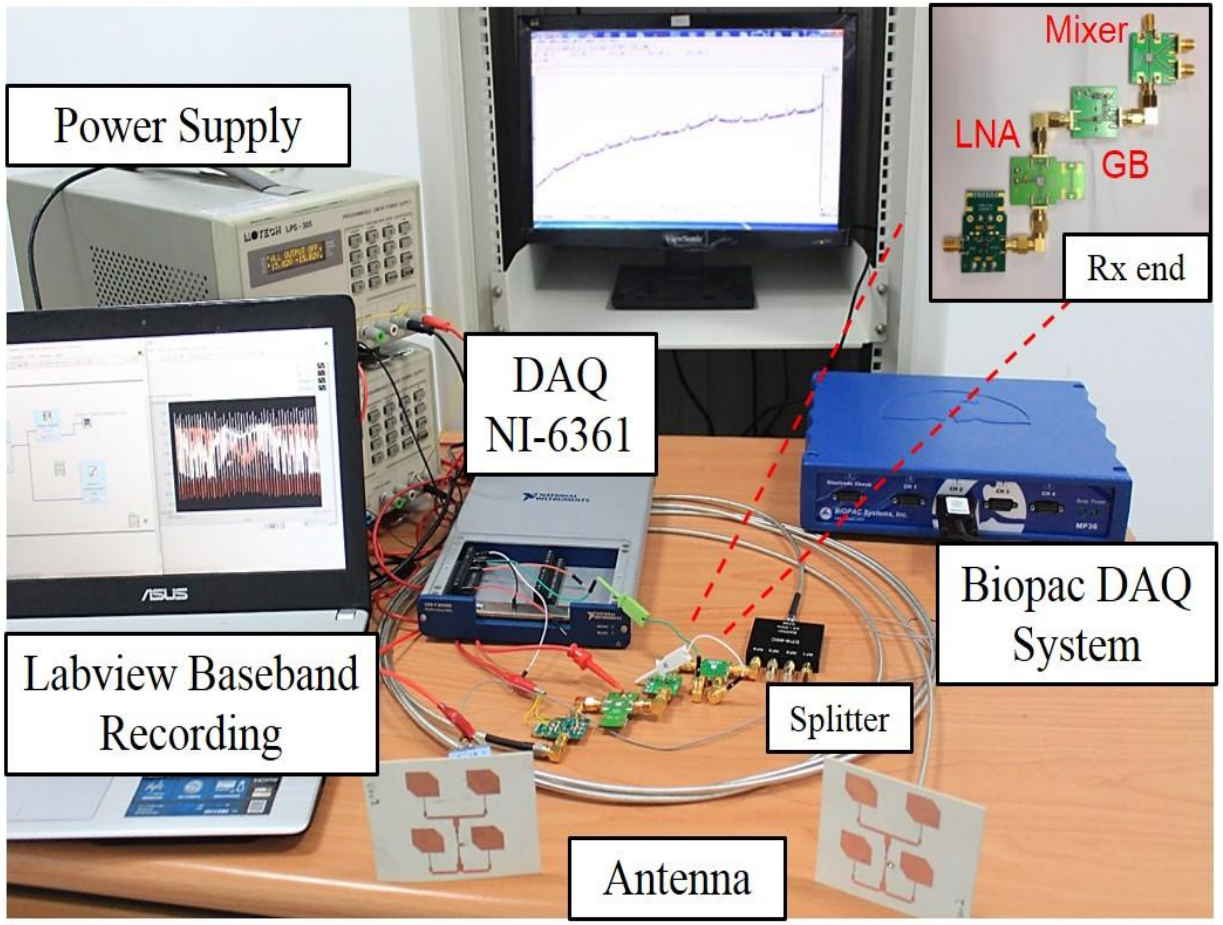


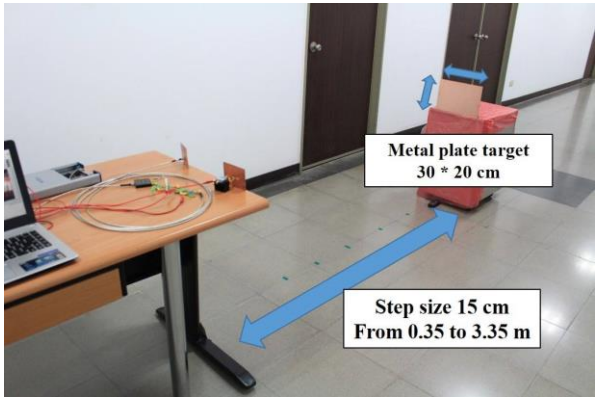
Step 1: Find peaks of beat frequency

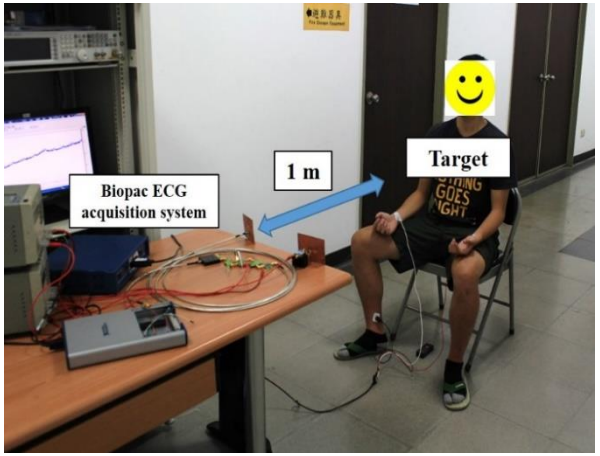
Step 2: Beat frequency drift (range-related) for vital sign extraction



System Setup & Experiment Scenarios







Spectra Analysis – CW/FMCW Mode

TABLE CURRENT METHOD TO DETECT HR FOR DIFFERENT RADAR TYPE

Research Group	Radar Type	Frequency	Method	Operating Range	Reported HR error
[15]	CW	12, 24 GHz	FFT/CSD	0.5 m	< 4.4 %
[16]	CW	5.8 GHz	CWT	0.5 m	2.53-4.83 %
[17]	FMCW	75-85 GHz	FFT	2 m	14.58 %
[18]	SFCW	3.14-3.46 GHz	SSM/FFT	1.2 m	< 1.2 %
[19]	IR-UWB	1.5-4.5 GHz	CSD/SSM	0.8 m	≤ 3.7 %
[7]	IR-UWB	3.1-10.6 GHz	MTI/CZT	1 m	≤ 2.4%
This Work	FMCW/CW	5.72-5.88 GHz	FFT/CSD/EMD	1 m	≤0.98% 3.83 %*