



1.1 Background and Motivation

1.1.1 6G and Future Wireless Systems

From the first generation to the fifth generation (5G), each generation of communication systems has been developed to meet the evolving needs of users and network operators. However, modern society is becoming increasingly data-driven and highly automated [1]. With the continuous development of the mobile internet and the Internet of Things, future wireless systems are facing unprecedented demand growth. A variety of new applications are emerging, such as extended reality (XR) [2], eHealth [3], holographic telepresence [4], industry 4.0 and robotics [5], and unmanned mobility [6, 7].

Different from conventional communication systems, which mainly focus on data rate, emerging wireless applications usually require multiple performance metrics simultaneously, including high-data-rate, low latency, high reliability, and massive connectivity. These requirements significantly increase the complexity of future wireless system design, especially in dynamic and dense communication environments [1, 2].

Therefore, 6G wireless systems are expected to support these emerging applications through further improvements in system capacity, coverage, and connectivity [1, 8]. In addition to communication services, future wireless systems are also expected to support functions such as real-time interaction, sensing, and large-scale device connectivity. As a result, wireless systems are gradually evolving from communication-centric architectures to more integrated multi-functional systems.

1.1.2 Integrated Sensing and Communication

For many emerging applications, wireless systems are required not only to transmit information efficiently but also to perceive and understand the surrounding environment in real time. Typical examples include autonomous driving, XR, and smart manufacturing [9].

However, conventional communication systems are mainly designed for data transmission, and their ability to obtain environmental information is limited. For example, they cannot directly provide key sensing-related information such as distance, velocity, or spatial structure [10]. As a result, these systems are not suitable for applications that require high sensing accuracy. At the same time, conventional sensing systems (e.g. radio detection and ranging (Radar)) are usually designed separately from communication systems, which leads to inefficient spectrum utilization and redundant hardware (HW) resources. With increasingly scarce spectrum resources,



this separated design makes it difficult to achieve both high data rate communication and high-accuracy sensing at the same time [11].

Furthermore, as wireless systems evolve towards higher frequency bands, larger antenna arrays, and higher levels of integration, communication and sensing systems are becoming more similar in terms of HW architecture and signal processing. This makes it possible to integrate these two functionalities within the same HW infrastructure [11]. In this context, future wireless networks are expected to gradually evolve toward perceptive networks, where communication services are integrated with continuous environmental sensing capabilities [9]. To address the above challenges, integrated sensing and communication (ISAC) has recently attracted significant attention as a new solution [12]. By jointly designing communication and sensing functions within a unified framework, ISAC allows them to share both spectrum and HW resources. This can improve spectrum efficiency and reduce system cost, size, and energy consumption [9]. In addition, ISAC enables mutual benefits between communication and sensing. Therefore, sensing is gradually becoming an integrated capability of future wireless systems, rather than just an auxiliary function [13].

1.1.3 Beamforming in Multi-Input Multi-Output Systems

The capacity of current wireless networks is limited by both physical layer performance and practical deployment constraints. To support future high data rate wireless systems, additional spectrum resources are required. Therefore, communication in higher frequency bands has attracted increasing attention [14, 15]. One important example is communication in the millimeter wave (mmWave) frequency range, which has attracted significant attention as a key technology for future high-capacity wireless networks due to the large amount of available spectrum [16]. At these frequencies, the much shorter wavelength allows a large number of antenna elements to be integrated into a compact array aperture, which makes highly directional beamforming (BF) feasible in practical transceiver (TRX) designs.

However, operating at mmWave frequencies also introduces new challenges. From the propagation perspective, mmWave signals experience much higher path loss [17] and are highly sensitive to blockage from obstacles such as walls and the human body, which may lead to link interruptions [18]. In addition, diffraction around obstacles is significantly reduced at mmWave frequencies, further limiting non-line-of-sight (NLoS) propagation. To compensate for these propagation impairments, highly directional BF and large antenna arrays are typically employed in mmWave systems.

The use of such large arrays at both transmitter (TX) and receiver (RX) is a key characteristic of mmWave multi-input multi-output (MIMO) systems. Typical array sizes reported in the literature range from 16 to 256 elements [19–21]. Even practical commercial systems already employ antenna arrays with several tens of elements. However, large antenna arrays together with practical implementation constraints make conventional fully-digital MIMO processing difficult to implement in mmWave systems [22, 23].

In addition, mmWave channels usually exhibit limited scattering and directional propagation characteristics, leading to sparse channel structures in the spatial domain. To compensate for the severe propagation loss and blockage sensitivity at mmWave frequencies, BF has become a key technique [24]. More specifically, BF applies complex weighting coefficients across antenna elements to achieve directional signal transmission or reception. By coherently combining the signals across the antenna array, the signal power toward desired directions can be enhanced

while interference from other directions can be suppressed. In antenna array systems, this directional enhancement is commonly referred to as BF gain [25].

However, implementing large antenna arrays in mmWave systems still faces several practical challenges, especially when high BF gain is required. Conventional digital beamforming (DBF) provides the highest flexibility and performance, but it requires a dedicated radio frequency (RF) chain for each antenna element, including components such as analog-to-digital converters (ADCs)/digital-to-analog converters (DACs) and mixers [26–29]. In large-scale MIMO systems with hundreds or even thousands of antenna elements, this fully digital architecture leads to an excessive number of RF chains, resulting in high HW cost and power consumption. This is inconsistent with the energy efficiency and cost constraints required for practical 5G/6G systems, and becomes particularly challenging for mmWave applications [29].

Moreover, analog beamforming (ABF) can reduce the number of RF chains, as well as the associated cost and power consumption. However, it suffers from limited flexibility in signal processing and cannot effectively support multi-stream transmission [30].

To address these limitations, hybrid beamforming (HBF) has emerged as a practical solution. It combines analog BF with digital baseband (BB) processing to reduce HW complexity while maintaining most of the performance advantages of DBF [25, 30, 31].

HBF can be implemented using different architectures, most commonly fully-connected (FC) and partially-connected (PC) architectures, which offer different trade-offs between performance and complexity. In the FC architecture, each RF chain is connected to all antenna elements, allowing for high BF flexibility and performance [25, 32]. In contrast, PC architectures reduce the number of connections between RF chains and antennas, leading to lower complexity and power consumption [33]. However, these connection constraints generally reduce the design flexibility and may result in some performance loss compared with FC architectures. Nevertheless, PC architectures can provide lower HW complexity, reduced power consumption, and improved energy efficiency [34, 35]. Therefore, selecting an appropriate HBF architecture is important for achieving a balance between performance and implementation complexity in mmWave systems.

In practical mmWave systems, the performance of HBF is not only determined by the BF algorithmic design itself, but is also significantly affected by HW constraints and non-ideal effects [31, 36]. In particular, nonlinear characteristics of power amplifier (PA) [37], finite-resolution phase shifters [38], and mutual coupling effects [39] in antenna arrays have been shown to degrade system performance. Therefore, it is essential to take these non-ideal factors into account when designing HBF systems for practical implementations.

With the increasing number of antenna elements in mmWave systems, achieving low-complexity implementation while maintaining system performance has become a key challenge for practical deployment [31, 36]. It has been shown that signal processing in massive MIMO systems can be computationally demanding, which motivates the use of parallel processing and HW acceleration to improve implementation efficiency [26, 34]. Therefore, in the design of HBF systems, it is necessary to consider not only performance optimization, but also practical aspects such as implementation complexity and scalability.

Motivated by the above challenges, this thesis focuses on the design of HBF techniques for MIMO systems. First, the HBF algorithms are developed under idealized system assumptions to demonstrate their performance and design principles. Based on this, practical constraints are considered, including HW non-idealities and implementation complexity, so that the proposed methods can be applied more efficiently in practical systems. In this way, the thesis aims to achieve a balance between theoretical performance and practical feasibility in HBF design.



1.2 State of the Art

1.2.1 HBF for mmWave MIMO Systems

HBF combines ABF in the analog domain with digital signal processing (DSP) at BB, enabling reduced HW complexity while approaching the performance of DBF [26, 40, 41]. Existing studies focus on the joint analog and digital BF design to achieve near-DBF performance [26, 42].

From an algorithm design perspective, the HBF design problem is typically formulated as an optimization problem. Due to the constant modulus constraint in ABF, coupled RF and BB variables, and other additional constraints, this optimization problem is generally non-convex, which usually requires heuristic or iterative optimization methods [43, 44].

To solve this problem, several methods have been adopted. Alternating minimization methods have been widely used to simplify complex problems by separating the joint problem into several sub-problems. In each iteration, only one variable is updated, as the other variables are fixed. The solution is gradually updated toward a local optimum [35, 45]. In addition to alternating optimization, other optimization-based approaches, including semidefinite programming (SDP)-based formulations and constrained optimization techniques, have also been investigated for solving HBF design problems [46].

Methods that exploit the sparse structure of mmWave channels have become a widely used approach. By utilizing the limited number of dominant propagation paths, sparse reconstruction techniques can be employed to approximate the optimal precoder using a small number of array response vectors [47]. Such approaches significantly reduce the optimization complexity while maintaining near-optimal performance in large-array systems [31].

In parallel, a number of implementation-oriented techniques have been proposed to facilitate practical deployment. Codebook-based BF designs reduce channel acquisition and feedback overhead through predefined beam sets and limited-feedback mechanisms [48, 49]. Antenna-selection and beam-selection schemes lower the required HW resources by activating only a subset of antennas or beams. Beam-space architectures based on lens arrays, such as continuous aperture phased MIMO (CAP-MIMO), further reduce the signal-processing dimension by transforming the signals into the beam domain [50].

1.2.2 HBF for ISAC

HBF has also been widely investigated for ISAC systems. Compared with conventional HBF design for communication systems, HBF design in ISAC must support both communication performance and sensing capability, leading to more complex multi-objective optimization problems. Depending on how communication and sensing metrics are incorporated into the optimization problem, existing works can be broadly categorized into communication-centric, sensing-centric, and joint (trade-off) designs [11, 51–56].

Communication-Centric

Communication-centric approaches treat communication performance as the primary optimization objective, e.g., by maximizing the achievable data rate [51], minimizing the mean squared error (MSE) [52], or improving metrics such as spectral efficiency (SE) [57]. In these methods, a communication metric is typically formulated as the objective in the optimization problem,

in which sensing requirements are imposed as constraints, such as radar signal-to-interference-plus-noise ratio (SINR) constraints [57] of the sensing target.

Sensing-Centric

In contrast, sensing-centric approaches treat sensing performance as the primary objective, by maximizing radar mutual information (RMI) [55], enhancing TX gain toward target directions [53], or designing TX beams that approximate a desired radar beampattern [54]. In addition, some approaches improve sensing performance by optimizing signal correlation or orthogonality [9]. In these methods, the communication performance metrics are then constrained in the optimization problem, e.g., achievable rate [55], suppression of inter-user interference (IUI) [53], or SINR of the communication user [54].

Trade-Off

More recently, joint trade-off design approaches have attracted increasing attention, which approaches incorporate both communication and sensing metrics into the optimization objective function. A common approach is to construct a weighted sum of communication and sensing performance metrics, e.g., by jointly optimizing communication SE and spatial spectrum matching error (SSME) of radar [58].

1.2.3 Direction of Arrival in ISAC

In ISAC systems, direction of arrival (DoA) estimation is a key task for acquiring spatial information of targets and plays an important role in target detection and tracking. Existing DoA methods are largely based on array signal processing theory and have formed a well-established research framework.

Classical DoA methods can be categorized into two types. The first category consists of conventional BF approaches, such as the Beamscan method, which estimates the signal direction by searching the array response over a predefined angular range. These methods are simple to implement but suffer from limited resolution [59]. The second category includes subspace-based methods, such as multiple signal classification (MUSIC) [60] and estimation of signal parameters via rotational invariance techniques (ESPRIT) [61], which achieve high-resolution DoA estimation by performing eigen-decomposition of the covariance matrix of the received signals [59].

However, these methods are typically developed for DBF architectures, in which complete observations from all antennas are required. In HBF systems, due to the limited number of RF chains, only low-dimensional signals after analog combining can be observed at the RX. This leads to a loss of spatial information and makes conventional DoA methods difficult to apply directly.

Several approaches have been investigated for DoA estimation under HBF architectures. Some approaches construct virtual arrays or subarray structures to map the compressed observations to an equivalent high-dimensional array model and then apply modified subspace-based algorithms for high-resolution DoA estimation [62]. In addition, another class of methods focuses on constructing or reconstructing the spatial covariance matrix (SCM) from low-dimensional observations, thereby enabling the application of conventional subspace

methods [63, 64]. Other approaches incorporate beam-sweeping strategies to obtain directional information, thereby improving estimation performance under compressed observations [65].

1.2.4 BF under HW Constraints

In practical mmWave systems, analog/RF components and digital processing units are subject to limited resolution and device imperfections that are often neglected in idealized models.

These effects are further exacerbated in HBF architectures, where the HBF process is split between analog and digital domains. In particular, PA nonlinearity, together with the reliance on finite-resolution phase shifters and electromagnetic coupling between elements, introduces additional distortion and makes the HBF system more sensitive to HW imperfections. Consequently, increasing attention has been paid to analyzing the impact of such HW constraints on HBF performance.

PA nonlinearity

In HBF systems, RF chain non-idealities, particularly the nonlinear behavior of PAs, can affect system performance. When PAs operate in or close to saturation regions, their nonlinear characteristics introduce signal distortion, leading to communication performance degradation and distorted sensing beampatterns.

Existing studies have investigated PA nonlinearity from different perspectives. Some studies treat this as a HW compensation problem. Digital predistortion (DPD) techniques are applied to mitigate nonlinear distortion without modifying the underlying BF structure [66, 67]. Some studies investigate the impact of practical PA behavior on communication performance metrics, such as SE and energy efficiency, and analyze the corresponding trade-offs under nonlinear PA conditions [68].

More recently, distortion-aware HBF approaches have been proposed. Instead of mitigating nonlinear distortion separately from the BF design, the PA non-idealities are explicitly incorporated into the BF design process, enabling the system to account for PA non-idealities during optimization [37].

Quantization and Low-Resolution HW Constraints

Low-resolution RF components are often considered in practical mmWave HBF systems to reduce HW cost and power consumption. Quantization effects may originate from finite-resolution phase shifters, low-resolution ADCs/DACs, and other limited-precision RF components. These effects introduce additional distortion and may reduce BF accuracy.

Some existing works investigate low-resolution phase-shifter structures together with the corresponding BF algorithms. Multi-layer analog phase-shifter networks and dedicated optimization strategies have been proposed to improve BF performance under low-resolution phase-shifter constraints while reducing complexity and power consumption [38].

Other works focus on low-resolution ADC/DAC architectures. Quantization-aware BF designs have been proposed by explicitly incorporating converter distortion into the system model, enabling the analysis of limited-resolution HW on communication performance [69, 70]. More recently, similar quantization-aware approaches have also been extended to ISAC systems [71].

Mutual Coupling

In practical antenna arrays, near-field electromagnetic interactions between closely spaced antenna elements lead to mutual coupling. In HBF systems, antenna elements are usually placed in compact arrays, which makes the coupling effect more pronounced. As a result, the effective array response can be distorted, leading to beam misalignment, reduced array gain, and degraded interference suppression. However, many existing HBF studies still assume ideal array models and do not consider coupling effects.

Some existing publications focus on antenna and array design, where antenna structures or isolation techniques are optimized to reduce coupling effects [72]. Other studies model mutual coupling through a coupling matrix and incorporate it into the system model to analyze its impact on channel characteristics and system performance [73]. In addition to algorithmic and system-level modeling, practical RF front-end and antenna package designs have also been investigated to mitigate coupling-induced degradation in compact mmWave arrays [74].

1.3 Contributions and Structure

1.3.1 Open Research Problems and Focus of This thesis

HBF Design under Ideal Hardware Assumptions

Existing HBF designs for ISAC systems under ideal HW assumptions mainly focus on three directions: communication-centric design, sensing-centric design, and joint communication-sensing trade-off optimization. However, several key challenges remain unresolved, particularly in PC architectures, where the limited RF-chain connectivity further complicates the joint optimization problem.

First, most existing works focus on either TX or RX design separately, lacking joint system-level modeling and optimization between the two sides [75, 76]. As a result, mismatches between TX and RX processing may occur. In particular, conventional orthogonal matching pursuit (OMP)-based combining methods [47], which are widely used in communication systems, may suffer from direction mismatch in ISAC systems, since the TX beams are no longer aligned only with the dominant communication channel directions. Furthermore, current approaches are typically communication-centric or sensing-centric, which may not simultaneously guarantee communication reliability and sensing performance in multi-user (MU) scenarios [52, 55, 56, 77]. Moreover, at the RX side, most existing works mainly focus on communication performance, while sensing-oriented RX processing is often treated only briefly and is less frequently considered within a complete HBF-based ISAC framework. Therefore, system-level algorithm modeling and optimization are still required for ISAC-HBF systems, including the TX as well as communication and sensing RX processing.

Non-Ideal HW-Aware Algorithm Design

Although there has been extensive research on HBF for mmWave ISAC systems, most existing studies have been conducted under idealized HW assumptions. Specifically, PAs have nonlinear and frequency-dependent characteristics, which introduce distortion and degrade both communication and sensing performance, especially in orthogonal frequency division multiplexing (OFDM) systems [68, 78]. However, in many existing HBF designs, the PA is still modeled as



an ideal linear component without distortion. Some existing works have considered the impact of PA nonlinearity on HBF systems, but most of them rely on DPD methods, which require additional HW [66, 67]. Some works further incorporate PA constraints into the HBF optimization process, but mainly through hard constraints, which may lead to excessively low signal power [37]. An efficient approach that allows the PA to operate in its efficient region while maintaining BF performance still remains open.

The impact of mutual coupling has already been analyzed, as it alters the effective array response and thereby affects beam directivity. But compensation methods have not yet been proposed [72, 73].

Low-resolution analog components have been analyzed to degrade system performance and introduce deviations from ideal BF behavior. Compensation methods for low-resolution components are mostly investigated for ADCs/DACs [69, 70]. Existing works on finite-resolution phase shifters mainly focus on HW redesign and the corresponding BF methods [38]. However, algorithm-level compensation for finite-resolution phase shifters still remains an open problem.

This motivates the investigation of HW-aware HBF design.

FPGA-Based Implementation of HBF

Most HBF algorithms are typically designed and simulated in software using floating-point arithmetic. However, the iterative computation of these algorithms leads to high computational complexity, making real-time implementation difficult in dynamic scenarios, such as moving targets. Due to their parallel processing capability, field programmable gate arrays (FPGAs) have attracted increasing attention for accelerating HBF algorithms.

However, FPGA implementations usually rely on fixed-point arithmetic and limited-precision data representations, which impose additional constraints and may degrade performance [79]. In addition, the large-scale matrix operations in HBF algorithms make direct FPGA implementation challenging due to limited HW resources.

Systematic implementation and validation of HBF on practical platforms such as FPGAs still remain limited. In heterogeneous computing systems, several questions also remain open, including how to partition the computation efficiently, how to design suitable parallel architectures, and how to balance latency against resource usage. Therefore, a gap still exists between HBF algorithm design and practical HW implementation.

Motivated by these challenges, this thesis investigates system-level HBF design together with HW-aware optimization and FPGA-oriented implementation. The next section introduces the main contributions of this thesis.

1.3.2 Main Contributions

This thesis investigates HBF for ISAC systems from three aspects: system-level HBF design under ideal HW assumptions, the impact of HW non-idealities together with corresponding optimization strategies, and FPGA-oriented implementation of HBF algorithms. Together, these investigations bridge the gap between ideal algorithm design and practical implementation.

System-Level HBF Design under Ideal HW Assumptions

An ISAC system with a PC-HBF architecture under ideal HW assumptions is designed. MU communication is supported through TX BF design [80]. A joint optimization problem is pro-

posed on the TX side, enabling a controllable trade-off between communication and sensing objectives. Sensing beams are derived from communication beams so that all RF chains remain available for MU transmission. Interior point method (IPM) is adopted to solve the optimization problem, and an initialization strategy is introduced to improve the convergence behavior.

For the communication RX, this thesis proposes a two-stage Block-OMP-based hybrid combining algorithm. Since traditional OMP-based hybrid combining methods are typically designed based on communication channel characteristics, mismatches may occur between the candidate directions in the dictionary and the actual beam directions generated by the ISAC TX. An adaptive dictionary selection and refinement (ADSR) strategy is introduced to reduce this mismatch.

For the sensing RX, a hybrid DoA estimation scheme combining beamsearch and MUSIC is employed. By using beamsearch prior to MUSIC processing, directional information can be retained after analog combining, enabling DoA estimation within the HBF RX structure.

The results show that the proposed system achieves communication performance close to FC-HBF and sensing performance close to DBF, while maintaining the reduced HW complexity of a PC-HBF architecture.

HW-Aware HBF under Non-Ideal Conditions

These impairments affect different parts of the HBF system and therefore require dedicated compensation strategies. Several HW impairments are considered, including PA nonlinearity, finite-resolution phase shifters and mutual coupling. Based on the corresponding analysis, HW-aware extensions of the HBF algorithms are developed to mitigate the resulting performance degradation [81–84].

High PA excitation levels introduce additional distortion into the transmitted and received signals. Moreover, for wideband transmission, the frequency-dependent characteristics of the PA lead to unequal amplification across different subcarriers. To address this problem, additional constraints, including soft and hard excitation constraints, are incorporated into the optimization problem to regulate the digital precoder, since it directly determines the PA input power. The hard constraint prevents the PA from entering the saturation region, while the soft constraint avoids operating far below the efficient region. In addition, a balance constraint is introduced to achieve more balanced amplification among different PAs. Simulation results show that the proposed PA-aware design can effectively suppress PA-induced distortion while maintaining operation within the efficient PA region, thereby improving robustness against PA nonlinearity. [82].

To avoid beam mismatch caused by the finite resolution of phase shifters, a discrete BF dictionary is proposed to ensure that the selected phase shifts are realizable. The remaining mismatch is then compensated through digital BF refinement. Simulation results show that the proposed design effectively reduces the SE degradation caused by phase quantization [84].

Mutual coupling in antenna arrays leads to beampattern distortion, which further reduces interference suppression capability and degrades SE. In this thesis, mutual coupling is incorporated into the system and algorithm design. The resulting distortion is compensated within both the TX and RX BF design, including the IPM- and OMP-based optimization procedures. The results indicate that the proposed coupling-aware design improves interference suppression and reduces BER degradation [83].



FPGA-Oriented Implementation and Algorithm–HW Co-Design

Due to the high computational complexity of HBF algorithms, direct FPGA implementation is challenging. In this thesis, an OMP-based hybrid combining algorithm is analyzed and partitioned between advanced RISC machines (ARM) and FPGA processing units. The computationally intensive operations are executed on the FPGA, while the remaining control and processing tasks are handled on the ARM side.

To improve implementation efficiency, several parallel processing architectures are proposed to balance latency and HW resource consumption. In addition, a quantization strategy is introduced to reduce the performance degradation caused by fixed-point implementation. Experimental validation in Vivado shows that the proposed architectures achieve different latency-resource trade-offs while maintaining the HBF performance. The results further demonstrate the feasibility of FPGA-oriented implementation for HBF systems [84].

The publications related to the contributions of this thesis are listed as follows:

- M. Zhang, T. Huang, T. Reissland, T. Maiwald, N. Franchi, and R. Weigel, “PA-Aware Partially-connected HBF Design for Wideband Integrated Sensing and Communication,” in *IEEE Journal of Microwaves*, vol. 6, no. 5, pp. 1285–1298, Sept. 2026, doi: 10.1109/JMW.2026.3728101 [82].
- M. Zhang, R. Weigel, N. Franchi, and T. Reissland, “Robust Hybrid Beamforming with Mutual Coupling Compensation for mmWave MIMO,” in *2025 Asia-Pacific Microwave Conference*, Dec. 2025, pp. 1–3. doi: 10.1109/APMC65046.2025.11378593 [83].
- M. Zhang, R. Weigel, N. Franchi, and T. Reissland, “FPGA-Based Hybrid Beamforming under Quantization and Phase Resolution Constraints,” in *2025 IEEE Workshop on Signal Processing Systems*, Nov. 2025, pp. 1–5. doi: 10.1109/SIPS66314.2025.11261282 [84].
- M. Zhang, Y. Su, N. Franchi, R. Weigel, and T. Reissland, “Hybrid Beamforming for Multi-User Joint Communication and Sensing With URA Under Partially Connected Architectures,” *IEEE Access*, vol. 13, pp. 170395–170409, 2025. doi: 10.1109/ACCESS.2025.3615453 [80].
- M. Zhang, T. Reissland, R. Weigel, G. Fischer and N. Franchi, “Hybrid Beamforming Design with Physical Layer Simulation Tool for JCAS Applications,” *2024 IEEE Asia-Pacific Microwave Conference*, Dec. 2024, pp. 683–685, doi: 10.1109/APMC60911.2024.10867726 [81].

In addition, the author contributed as a co-author to a study on radar data compression for efficient transmission and storage in distributed radar networks. The thesis investigates the applicability of standard and radar-specific compression methods and analyzes their impact on data rate reduction and signal quality, demonstrating the potential of high compression ratios for radar data processing.

- G. Körner, M. Hoffmann, P. Stief, M. Zhang, R. Rückert, C. Herglotz, A. Kaup, and M. Vossiek, “Applicability and Performance of Standard Compression Methods for Efficient Data Transmission and Storage in Radar Networks,” *IEEE Journal of Microwaves*, vol. 2, no. 1, pp. 78–96, Jan. 2022. doi: 10.1109/JMW.2021.3119781 [85].