**OUTLINE GRADUATION THESIS**

**Tên đề tài:** Định vị trong hệ thống 5G MIMO Millimeter wave bằng phương pháp Distributed Compressive Sensing (S-OMP)

**THESIS TITLE:** Position Estimation Through MillimeterWave MIMO in 5G Systems using Distributed Compressive Sensing (S-OMP)

**ABSTRACT**

Millimeter wave signals and large antenna arrays are considered enabling technologies for future 5G networks. While their benefits for achieving high-data rate communications are well-known, their potential advantages for accurate positioning are largely undiscovered. We derive the Cramér-Rao bound (CRB) on position and rotation angle estimation uncertainty from millimeter wave signals from a single transmitter, in the presence of scatterers. We also present a novel two-stage algorithm for position and rotation angle estimation that attains the CRB for average to high signal-to-noise ratio. The algorithm is based on multiple measurement vectors matching pursuit for coarse estimation, followed by a refinement stage based on the spacealternating generalized expectation maximization algorithm. We find that accurate position and rotation angle estimation is possible using signals from a single transmitter, in either lineof-sight, non-line-of-sight, or obstructed-line-of-sight conditions

In this work, we model a 5G downlink channel using millimeter-wave (mmWave) and massive Multiple-Input Multiple-Output (mMIMO) technologies, considering the following localization parameters: Time of Arrival (TOA), Two-Dimensional Angle of Departure (2D-AoD), and Two-Dimensional Angle of Arrival (2D-AoA), both encompassing azimuth and elevation. Our research focuses on the precise estimation of these parameters within a three-dimensional (3D) environment, which is crucial in Industry 4.0 applications such as smart warehousing. In such scenarios, determining the device localization is paramount, as products must be handled with high precision. To achieve these precise estimations, we employ an adaptive approach built upon the Distributed Compressed Sensing—Subspace Orthogonal Matching Pursuit (DCS-SOMP) algorithm. We obtain better estimations using an adaptive approach that dynamically adapts the sensing matrix during each iteration, effectively constraining the search space. The results demonstrate that our approach outperforms the traditional method in terms of accuracy, speed to convergence, and memory use.

***Keywords: :*** *5G; compressed sensing; DCS-SOMP; parameter estimation; position estimation;*

**TÓM TẮT**

***Từ khóa:***

**AUTHORSHIP**

*“I hereby declare that the work contained in this thesis is of my own and has not been previously submitted for a degree or diploma at this or any other higher education institution. To the best of my knowledge and belief, the thesis contains no materials previously published or written by another person except where due reference or acknowledgement is made.”*

Signature:………………………………………………

**SUPERVISOR’S APPROVAL**

*“I hereby approve that the thesis in its current form is ready for committee examination as a requirement for the Bachelor of Electronics and Telecommunication degree at the University of Engineering and Technology.”*

Signature:………………………………………………

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**TABLES OF CONTENT**

**LIST OF FIGURES**

**LIST OF TABLES**

**ABBREVATIONS**

**CHAPTER 1: INTRODUCTION**

* 1. Motivation
  2. Contributions and thesis overview

Tính cần thiết của đề tài, ý nghĩa khoa học và thực tiễn, đối tượng và phương pháp nghiên cứu, nội dung nghiên cứu

In this work, the authors propose a comprehensive localization algorithm using MIMO, mmWave, and ULA. They employ the DCS-SOMP method for parameter estimation. Due to the linear antenna array, the method applies to a 2D environment. Additionally, the DCS-SOMP method provides only a coarse parameter estimate, demanding further fine-tuning using the SAGE methodIn [5], the authors propose a comprehensive localization algorithm using MIMO, mmWave, and ULA. They employ the DCS-SOMP method for parameter estimation. Due to the linear antenna array, the method applies to a 2D environment. Additionally, the DCS-SOMP method provides only a coarse parameter estimate, demanding further fine-tuning using the SAGE method

- Estimate AoA and AoD using DSC-SOMP from channel modeling using MIMO and mmWave.

- Employ the DCS-SOMP method for parameter estimation. Due to the linear antenna array, the method applies to a 2D environment. Additionally, the DCS-SOMP method provides only a coarse parameter estimate, demanding further fine-tuning using the SAGE method

* 1. Related work
  2. Thesis layout

The remainder of this article is organized as follows: in Section 2, a literature review is presented. Section 3 outlines the system model, focusing on the channel and received signal modeling. Section 4 elaborates on constructing the sensing matrix and applying the DCS-SOMP method, including the proposed modification for adaptive search in the sensing matrix. In Section 5, simulation results are presented and discussed. Finally, Section 6 concludes the article

**CHAPTER 2: BASIC THEORIES OF 5G SYSTEM**

2.1. System Model

2.1.1. Transmitter Model

2.1.2. Channel Model

2.1.3. Received Signal Model

2.2. Basic theory of compressed sensing

2.3. Methods for 5G mm-wave channel estimation

2.3.1. L1 trực tiếp

2.3.2. L1 gián tiếp

- FISTA

- L1-LS

2.3.3. Sparse Bayesian Inference

Tổng kết chương II

**CHAPTER 3: POSITIONING PROBLEM THROUGH MILLIMETER WAVE MIMO IN 5G SYSTEM**

3.1. Overview about channel estimation

3.2. OMP Algorithm

OMP (Orthogonal matching pursuit) - single subcarrier

3.3. S-OMP Algorithm

S-OMP (Simultaneous orthogonal matching pursuit) - multiple subcarrier

* Distributed Compressive Sensing
* AOA, AOD => Positioning
* Advantages of S-OMP compared to OMP

3.4. Positioning methods using channel information (channel estimation)

Tổng kết chương III

**CHAPTER 4: SIMULATION**

4.1. Simulation Setup

4.2. Simulation Results

4.3. Discussion

Tổng kết chương IV

**CONCLUSION**

Conclusions

Future Works

**APPENDIX**

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