**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**

Nowadays, large antenna arrays and millimeter wave signals are thought to be key technology for upcoming 5G networks. Their potential benefits for precise positioning are largely unexplored, despite their well-known benefits for attaining high-data rate communications. In this thesis, a 5G channel using millimeter-wave (mmWave) and massive Multiple-Input Multiple-Output (mMIMO) technologies is simulated, considering the following localization parameters: Time of Arrival (TOA), Angle of Departure (AoD), and Angle of Arrival (AoA). To achieve these precise estimations, I employ an approach built upon the Distributed Compressed Sensing—Subspace Orthogonal Matching Pursuit (DCS-SOMP) algorithm. In the presence of scatterers, we estimate the Cramér-Rao bound (CRB) on location and rotation angle estimation uncertainty from millimeter wave signals from a single transmitter. Additionally, we describe a ***novel*** two-stage algorithm for position and rotation angle estimation that attains the CRB for average to high signal-to-noise ratio. For coarse estimation, the approach is based on the multiple measurement vectors matching pursuit, followed by a refinement stage based on the space alternating generalized expectation maximization (SAGE) algorithm. Finally, we estimate accurate position and rotation angle, which is possible using signals from a single transmitter, in line-of-sight, non-line-of-sight, or obstructed-line-of-sight scenarios.

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

**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:………………………………………………

**ACKNOWLEDGMENT**

I would like to express my sincere gratitude to … (should be your supervisors)

I am grateful to … (should be your tutor)

I would like to also thank … (should be your colleagues, friends who have helped you along)

I greatly appreciate the following organizations… (the Department/Lab where you did your thesis work, the University of Engineering and Technology, companies involved, …)

This thesis was partly supported by the [e.g., Vietnam National University Hanoi] under the project XYZ.

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**ABBREVIATIONS**

**CHAPTER 1: INTRODUCTION**

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

**1.1. Motivation**

In today's technological age, the application of 5G networks is growing in popularity, and having the ability to accurately estimate the location and angle of rotation of devices in 5G networks will play an important role in many areas such as intelligent transportation, object tracking and positioning, and personal communications

Mm-wave and massive multiple-input-multiple-output (MIMO) will likely be adopted in fifth generation (5G) communication networks, thanks to a number of favorable properties. Particularly, due to exploiting the carrier frequencies beyond 30 GHz and large available bandwidth, mm-wave can provide high data rate. This can be obtained through dense spatial multiplexing with large antennas. A sparse signal recovery problem exploiting the sparse nature of mm-wave channels is formulated for channel estimation based on the parametric channel model with quantized angles of departures/arrivals (AoDs/AoAs), called the angle grids. The problem is solved by the orthogonal matching pursuit (OMP) algorithm employing a redundant dictionary consisting of array response vectors with finely quantized angle grids. However, OMP (Orthogonal matching pursuit) is only used for single subcarriers, to estimate accurate position and rotation angle, S-OMP Algorithm for multiple subcarriers (Simultaneous orthogonal matching pursuit) is used. 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.

**1.2. Related work**

**1.3. Contributions and thesis overview**

The contributions of this thesis are described as follows:

- This thesis presents a method for estimating position and angle of rotation accurately through mm-wave signals from a single transmitter, even in conditions of obstructions. - This method achieves the Cramér-Rao limit (CRB) for the estimation of position and angle of rotation under the signal-from-one-way-mains-correct condition from a single transmitter.

- The method proposed in the thesis uses advanced signal processing and measurement techniques such as compressed sensing and expectation maximization algorithms to achieve accurate position and angle estimation. This method is different and advanced from traditional methods. This opens up the potential of mm-wave signals and large MIMO antennas in locating and orienting devices in 5G networks.

- This thesis proposes a method for determining position and direction using mm-wave signals from a single emitter, including in conditions of obstacles.

- The results of the study show that it is possible to determine the correct position and direction using magnetic signals from a single emitter, regardless of whether or not a direct line of sight, an indirect line of sight, or an obscured line of sight.

**1.4. Thesis layout**

The remainder of this article is organized as follows:

In Chapter 2, a literature review about basic theories of 5G system including system model, basic theory of compressed sensing and methods for 5G mm-wave channel estimation is presented.

Chapter 3 presented the details of positioning problem through millimeter wave MIMO in a 5G systemincluding overview about channel estimation, OMP Algorithm, S-OMP Algorithm and positioning methods using channel information (channel estimation).

In Chapter 4, simulation results are presented and discussed.

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

2.1. System Model

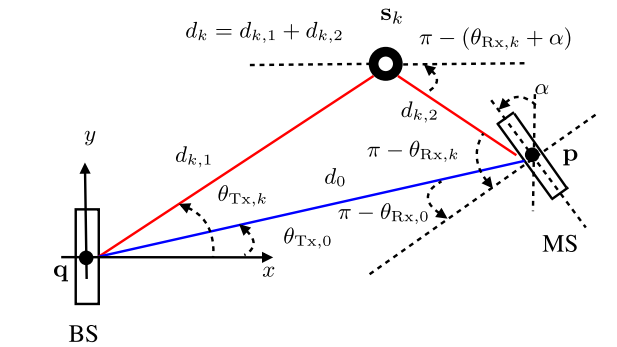


Figure 1: Two dimensional illustration of the LOS (blue link) and NLOS (red link) based positioning problem. The BS location ***q*** and BS orientation are known, but arbitrary. The location of the MS ***p***, scatterer rotation angle ***α, AOA θRX, AOD θTX***, the channel between BS and MS, and the distance between the antenna centers are unknown

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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