mmCEsim
https://mmcesim.org

mmCEsim Documentation & Tutorials

Task-oriented mmWave Channel Estimation Simulation

Version 0.1.0

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Preface

mmCEsim documentation & tutorials are under development!

I would like to thank Jinwen Xu for designing the elegant LaTeX template `beaulivre`, which empowers this document.

Wuqiong Zhao
Nanjing, China
January 2023

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I

PRELIMINARY

Make preparations before we start.

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1 Preview

Before diving into documentation details, let's first have a preview of mmCEsim. Maybe you are not sure whether your research or study need this powerful tool, then read this chapter to have a glimpse of mmCEsim.

1.1 Introduction

The application is dedicated to simulate millimeter wave (mmWave) channel estimation:

mmCEsim = **mm**Wave + **C**hannel **E**stimation + **sim**ulation,

where reconfigurable intelligent surface (RIS), also known as intelligent reflecting surface (IRS) [1] is supported for multiple input multiple output (MIMO) systems.

Figure 1.1: mmCEsim banner.

We offer a task-oriented simulation software for researchers to focus on algorithms only without being bothered by coding.

1.2 Features

Here is a list of basic features of mmCEsim:

- Task-oriented mmWave channel estimation formulation;
- Customizable system model;
- Extendable algorithms with our designed ALG language;
- Multiple RISs support;
- Automatic report generation (in plain text and LaTeX);
- Well-written documentation with examples and tutorials.

1.3 Algorithm Background

The task-oriented channel estimation for (RIS-assisted) mmWave MIMO systems is implemented with compressed sensing (CS), which exploits the sparsity of mmWave channels.

1.4 Software Implementation

Based on the algorithm background, we implement this software with command line interface (CLI), graphic user interface (GUI), web application and a VS Code extension.

2 Installation

So far, there is no built binary for mmCEsim since it is still under development. However, you may clone the GitHub repository and compile it yourself.

```
git clone https://github.com/mmcesim/mmcesim.git --recurse-submodules
cd mmcesim
cmake .
make
```

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II

DOCUMENTATION

Every syntax and option in details.

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3 CLI Application

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4 GUI Application

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5 Web Application

The example web app page is shown in Fig. 5.1.

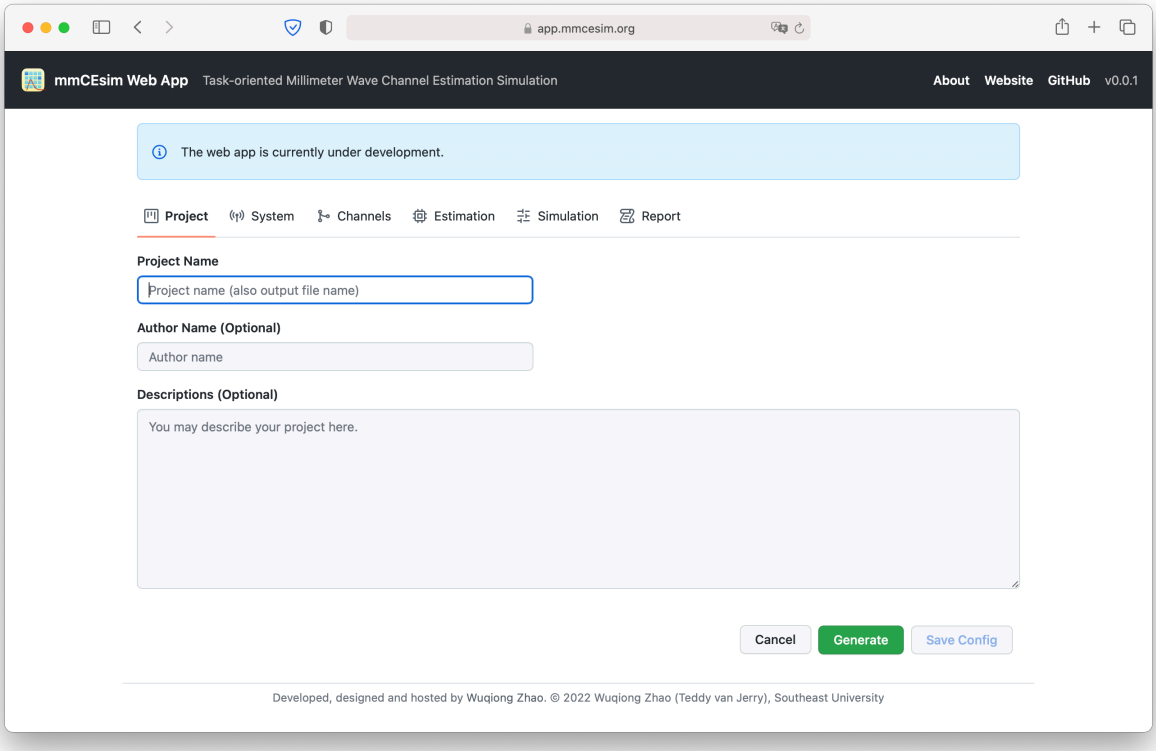

Figure 5.1: Web app interface.

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6 ALG Language

6.1 Data Type

6.1.1 Why Need Data Type

Languages Python and Matlab/Octave are weakly typed which can be convenient for writing the code. However, that is problematic for implementation. The efficiency is not satisfactory compared to C++, and sometimes you may encounter ambiguous error information in Matlab. Therefore, for the sake of efficiency and generality, ALG language is designed to be **strongly typed**.

6.1.2 Structure

The type specification is very simple, because ALG language concentrates on matrices. Basically, the structure of ALG language is

prefix + dimension + suffix.

For example, `f2c` means a matrix (dimension is 2) with data type as float and property as a constant.

6.1.3 Specifiers

6.1.3.1 Prefix

Basic Type Prefix Basic type just names the element type. They are shown in Table 6.1.

Table 6.1: Basic type prefix.

Predix	Type	C++ Type	Python Type	Matlab/Octave Type
c	Complex	cx_double	complex	complex
f	Float	double	double	double
i	Integer	int	int	int64
u	Unsigned Integer	uword	uint	uint64
b	Boolean	bool	bool	logical
s	String	std::string	str	string
h	Character	char	char	char

Alias Prefix Alias prefixes not only set the element type, but also the dimension. They are the one character alias for a two-character type.

III

TUTORIALS

Step-by-step guide on using mmCEsim.

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7 Millimeter Wave Channel Estimation

Millimeter wave channel estimation for multiple input multiple output (MIMO) systems techniques are discussed in [2].

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CLI Application Tutorials

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9 GUI Application Tutorials

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VS Code Extension Tutorials 11

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APPENDIX

Additional information about mmCEsim.

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Additional Resources

A.1 Publications

A brief introduction of mmCEsim is given in the poster at the 2022 National Postdoc Seminar in Nanjing, which I attend as the only undergraduate student, and got the Honorable Mention award.

This document is also published online at https://pub.mmcesim.org/mmCEsim-doc.pdf.

A.2 Websites

A.2.1 For Users

If you are the user of mmCEsim and wants to know more, you may find the following websites in Table A.1 useful.

Table A.1: Websites for users.

Website	URL
mmCEsim Homepage	https://mmcesim.org
Web Application	https://app.mmcesim.org
Blog	https://blog.mmcesim.org
Publications	https://pub.mmcesim.org
VS Code Extension	https://marketplace.visualstudio.com/items?itemName=mmcesim.mmcesim

A.2.2 For Developers

If you are a developer and maybe want to contribute to the mmCEsim project, you can find additional websites in Table A.2.

Table A.2: Websites for developers.

Website	URL
GitHub Organization	https://github.com/mmcesim
C++ Dev Documentation	https://dev.mmcesim.org
CLI App Wiki	https://github.com/mmcesim/mmcesim/wiki

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Bibliography

[1] Q. Wu and R. Zhang, "Towards smart and reconfigurable environment: Intelligent reflecting surface aided wireless network", *IEEE Commun. Mag.*, vol. 58, no. 1, pp. 106–112, Jan. 2020.

[2] J. Lee, G.-T. Gil, and Y. H. Lee, "Channel estimation via orthogonal matching pursuit for hybrid MIMO systems in millimeter wave communications", *IEEE Trans. Commun.*, vol. 64, no. 6, pp. 2370–2386, Jun. 2016.

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