



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 L^AT_EX template beaulivre, which empowers this document.

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I

PRELIMINARY

Make preparations before we start.

Preview | 1

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:

$$\text{mmCEsim} = \text{mmWave} + \text{Channel Estimation} + \text{simulation},$$

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.

Installation | 2

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.

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



DOCUMENTATION

Every syntax and option in details.

CLI Application | 3

GUI Application | 4

Web Application | 5

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

The screenshot displays a web browser window with the address bar showing `app.mmcesim.org`. The page title is "mmCESim Web App" with a subtitle "Task-oriented Millimeter Wave Channel Estimation Simulation". Navigation links for "About", "Website", "GitHub", and "v0.0.1" are in the top right. A light blue notification bar at the top states: "The web app is currently under development." Below this is a horizontal menu with icons and labels for "Project", "System", "Channels", "Estimation", "Simulation", and "Report". The "Project" tab is active. The form includes three main sections: "Project Name" with a text input field containing the placeholder "Project name (also output file name)"; "Author Name (Optional)" with a text input field containing the placeholder "Author name"; and "Descriptions (Optional)" with a large text area containing the placeholder "You may describe your project here." At the bottom right of the form are three buttons: "Cancel", "Generate" (highlighted in green), and "Save Config". A footer at the very bottom reads: "Developed, designed and hosted by Wuqiong Zhao. © 2022 Wuqiong Zhao (Teddy van Jerry), Southeast University".

Figure 5.1: Web app interface.

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	<code>cx_double</code>	<code>complex</code>	<code>complex</code>
f	Float	<code>double</code>	<code>double</code>	<code>double</code>
i	Integer	<code>int</code>	<code>int</code>	<code>int64</code>
u	Unsigned Integer	<code>uword</code>	<code>uint</code>	<code>uint64</code>
b	Boolean	<code>bool</code>	<code>bool</code>	<code>logical</code>
s	String	<code>std::string</code>	<code>str</code>	<code>string</code>
h	Character	<code>char</code>	<code>char</code>	<code>char</code>

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.

6.2 Function

6.3 Calculation (CALC)

6.4 Macro

6.5 ALG Library

III

TUTORIALS

Step-by-step guide on using mmCEsim.

Millimeter Wave Channel Estimation



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

CLI Application Tutorials



GUI Application Tutorials



Web Application Tutorials | 10

VS Code Extension Tutorials

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APPENDIX

Additional information about mmCEsim.

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

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.

