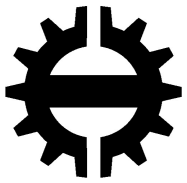

TAMPERE UNIVERSITY OF TECHNOLOGY
Institute of Communications Engineering

TLT-6206

Radio propagation in wireless networks

MIMO MATLAB Work

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INTRODUCTION

The target of the assignment is to familiarize the student with MIMO channel modeling. The work is based on L. Schumacher's MIMO channel model implementation, with added capacity analysis. First the channel model implementation is introduced, and thereafter analysis on MIMO channel with different parameters is done. Finally a short report on the results is written.

ASSIGNMENTS

PROBLEM 1 – Getting familiar with the tool

The MATLAB-codes and documentation for the channel model implementation can be found from http://www.cs.tut.fi/tlt/RNG/course_material/project.zip Go through the implementation_note_MIMO_Matlab.pdf. Extract all the m-files in one directory, and open the main file of channel modeling: example_MIMO.m. The main parameters for the simulation are in the beginning of the file, have a look on them. The selection of channel used is made by Three_GPP_Case. Thereafter, open other parameterization file, Three_GPP_Cases.m. Channel parameters are defined there (CASE 1 ... CASE 4). Case 1 defines simple Rayleigh fading channel, and cases 2-4 define ITU pedestrian and vehicular channels.

You can have a test run for the simulator by running the example_MIMO.m. It takes a while, and you are able to follow the progress from the display. Finally you result in having 4 graphs of the MIMO-channel. You may result in warning: sum(pdp) <> 1, but that is not dangerous. In Figure 1, amplitude all the multipath components in each channel are shown in time scale. In Figure 2, tap indexes for each channel are shown, and in Figure 3, correlation between each channel is shown. Figure 4 shows the Doppler spectrum for each multipath/channel.

After running the `example_MIMO`, you can analyze the capacity of the channel by running `MIMOcapacity`, which gives channel capacity in bits/Hz as an output. In case of problems during the work don't hesitate to ask for advises by email, but first read through the instructions carefully.

PROBLEM 2 – Parameters

The comments for the parameters in example_MIMO.m should explain themselves. `NumberofIterations` defines the length of the channel. 256 is the lowest acceptable for statistical reliability, but you can run also longer channel if you have fast-enough computer (i.e. 512 or 1024). For the following parameters, explain shortly how they affect on the MIMO channel capacity.

`Speed_kmh:`

`NumberOfAntennas_NodeB:`

`Spacing_NodeB`

```
NumberOfAntennas_UE

Spacing_UE

Three_GPP_Case
```

And also for Three_GPP_Case.m:

```
PDP_dB, Average power [dB]:

PDP_dB, Relative delay (ns):

Rician K_factor_dB:
```

PROBLEM 3 – Effect of changing parameters

Test the affect of different parameters on MIMO channel capacity:

- Run the simulation with $MIMO_{(MxN)}$ channels:
  SISO:(1,1), MIMO (2,2), MIMO (3,3), and MIMO (4,4)
  (Don't mind the warnings in example_MIMO in 1,1 –scenario, they are due to trying to plot channel correlations in one-channel case.)

- Run the simulations with three different antenna spacing; 0.01 λ, 0.5 λ, and 2 λ.

- Run the above simulations with two different channels: Rayleigh fading and some of the ITU channels, i.e. Cases 1 and {2,3,4}.

- Test one scenario, i.e. MIMO (2,2), with antenna spacing 0.5 λ, with all four channels, Rayleigh, ITU Pedestrian A, Vehicular A, and Pedestrian B,

You result in 4*3*2+4=28 simulations. Remember to `clear all` the variables from the workspace between the simulations.

Note that simulation with greater number of antennas and multipath channels increases the simulation time, if you have a very slow computer and end up in simulation time of tens of minutes with MIMO (4,4) –scenario, you can consider skipping it and running with 3 different channels.

- Explain what and why happens in each scenario and present the results in a couple of figures, and discuss the effect of different parameters on the system capacity (i.e. what is the effect of antenna spacing in different channels) with short explanations.

POST ASSIGNMENT

1° Check that you have run all the simulations and answered to all questions presented.

2° Any suggestions to improve the project work? What was good and what was bad?

3° Analysis of the simulation and answers to the questions has to be returned in a form of written report. Return the written report **by the end of 2nd period** via email in pdf format to address tero.isotalo@tut.fi with subject: *TLT-6206 Project*, or printed versions to TG218.

LITERATURE:

L. Schumacher, Description of the MATLAB implementation of a MIMO channel model suited for link-level simulations.

J. Niemelä, TLT-6206 Radio propagation in wireless networks, MIMO lecture material.