Test data for spatial field reconstruction

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Wireless sensor networks (WSN) are often applied to estimate the distribution of a spatial field, but they provide only measurements at a limited set of points. The task of spatial field reconstruction includes smoothing and interpolation of the data for any point in space. For compressed data transmission it is necessary to describe the field by a reduced set of parameters. Several related algorithms have been described in (Jedermann and Paul, 2016). Test data for comparison of the accuracy of the different algorithms were generated by COMSOL simulation (section 2).

The following 2-dimensional test data set contains a simulation of 3 heat sources in a water basin, including the effects of diffusion, horizontal heat transfer by a small flow (advection) and the influence of walls. The data set can be used for own studies under the condition that the **original article** (Jedermann and Paul, 2016) is quoted. Feedback on improved algorithms is encouraged. The data can be either exported from the COMSOL simulation or the generated MATAB files can be directly used.

Before testing algorithms for spatial field reconstruction, a limited set of sensors has to be selected from the data (e.g. 200) and noise has to be added (e.g. $\sigma=0.1$). We recommend using the MATLAB script *'loadTestData.m'* for this purpose. The script can either generate a new noise instance and new sensor positions for each call (mode 'p'), or repeat always the same values (mode 'r'). The first 4 sensors were fixed to the corners of the field in the latter case; all other sensor locations were set randomly.

The clean reference data without noise should only be used to evaluate the accuracy of the estimated field.

Remarks on COMSOL files

The data set was generated with COMSOL version 5.0. The data set used in the article was generated with *'normal'* mesh size. In order to increase accuracy of the simulation, we later increased the accuracy to *'fine'* and manually reduced the variable *'size1'* from 0.099 to 0.025.

The exported MATLAB files with *'normal'* mesh are stored with the extension *'*_IJDSN.mat'*, but we recommend to use the *'fine'* files.

Advection in fluids is present in most realistic scenarios and should be included in the simulation. Nevertheless, it can be switched off by setting the Global→Definitions→Parameters 'FlowOn' to zero.

File	Description
SpatialTestData_Web_v09_nonCKL	Comsol file
SensorData_xy2000.txt	Position table to export temperature values at sensor locations

Parameters of MATALB function loadTestData

Parameter	Description / possible values
S_max	number of selected sensor positions s_max ≤1000
noiseLevel	Amplitude / standard deviation of Gaussian noise 0≤noiseLevel≤0.5
comsolMesh	size of COMSOL mesh 'n' = normal (to reconstruct Data of article)

	'f' = fine (recommended for future use)
randomMode	'r' = repeat (generate always the same set of sensors and instance of noise)
	'n' = new noise (only new noise instance for each call)
	'p' = pulling (sensor positions randomly pulled from a set of 2000 samples, random noise, recommended)

Return values	Description / fields
SensorData	Generated sensor data with
	x,y = coordinates
	zMess = Simulated noisy measurements
	zClean = Clean simulation data at sensor position
CleanData	Reference data on grid points
	xVec, yVec = Grid coordinates
	zMatrix = Simulated field values

List of MATLAB scripts

The files are include in the ZIP-archive *'SpatialTestDataMatlab.zip'*

Script	Description
loadTestData.m	Adding noise to test data and plotting
plotCeanData.m	Plotting the reference data
plotNoisyMeasurements.m	Plotting locations and values of simulated sensors
DemoLoadData.m	Demonstration of data loading and plotting

List of MATLAB data files

Matlab Data file	Description
CleanGridConvection_IJDSN.mat CleanGridConvection_fine.mat	Field values on a grid of 52 by 52 points
CleanGrid256Fine.mat	Larger file with 256 by 256 points
SensorDataConvection1000_IJDSN.mat SensorDataFine2000.mat	Field values at sensor positions
DataRandom1000.mat	Random data to reproduce the noise for repeated tests

Maxima of the field

The simulated temperature field has the following maxima, according to an interpolation of the data in the file 'CleanGridConvection_fine.mat':

X [m]	y[m]	T [°C]
+0.5034	-0.3251	+0.968147
-0.2549	+0.6007	+0.579683
-0.3605	-0.3579	-0.080361

Downloads

The files are available at http://www. intelligentcontainer.com/en/downloads/spatial-test-data.html

- Comsol File
- Matlab Files (Zip)
- Large set 256 by 256

Please quote the following article, if you use this data set:

- Jedermann, R. and Paul, H. (2016). Identifying methods for accurate reconstruction of spatial fields in wireless sensor nets under data transmission limits. International Journal of Distributed Sensor Networks, Hindawi