How to process data acquired in MIMO-SAR mode:

Various processing scripts have been created in the framework of AnBa's dissertation. The relevant ones have been published on GitHub (https://github.com/abgbaumann/MIMO-SAR) or can be found on the server (gsgstaff\Research\04_InternalPhD\Baumann_Andreas\50_Processing_Final)

D00_sample_data	26/07/2022 12:23	File folder	
D01_documentation	28/10/2022 14:54	File folder	
P01_real_acquisitions	24/10/2022 12:42	File folder	
P10_numerical_simulation_of_acquisitions	08/09/2022 10:03	File folder	
P20_least_square_adjustment	08/09/2022 17:45	File folder	
P30_video_tracking	27/10/2022 16:24	File folder	
P40_total_station_tracking	27/10/2022 15:47	File folder	
P99_basic_functions	08/09/2022 10:08	File folder	
P01_RD_processing_phaseMismatchCalibration_sample.m	14/08/2022 17:56	MATLAB Code	2 KB
P02_RD_processing_phaseShiftCalibration_sample.m	14/08/2022 20:08	MATLAB Code	2 KB
P03_RD_configuration_TxBF_sample.m	15/08/2022 13:11	MATLAB Code	3 KB
P03_RD_processing_MIMO_sample.m	25/10/2022 10:25	MATLAB Code	14 KB
P03_RD_processing_TxBF_sample.m	18/08/2022 13:57	MATLAB Code	2 KB
P10_NS_processing_sample.m	08/09/2022 09:44	MATLAB Code	33 KB
P20_LSQ_processing_sample.m	08/09/2022 17:38	MATLAB Code	11 KB

The sample script for processing MIMO-SAR is the **P03_RD_processing_MIMO_sample.m**. an looks as followed:

```
%% The following script is a sample script for processing radar data acquired with a TIDEP-01012 system

%% Clear everything
close all
clearvars
clc

%% Initalisation
[file_dir,~,~] = fileparts(matlab.desktop.editor.getActiveFilename);
addpath(genpath(fullfile(file_dir)));

% Define Project
proj_list = {'MIMO_A77_Calandawind_20220914_124115_00240000ms';}; % Project name consistent with <project_name>

filt_by_dist_list = {{1,125,175};}; % Distance Limitation {True/False, D_Min, D_Max}

filt_by_azi_list = {{1,-26,30};}; % Azimuth Limitation {True/False, Az_Min, Az_Max}

filt_by_asi_list = {{0,-inf};}; % Filter by Amplitude Stability Index {True/False, ASI_Min}

filt_by_lr_list = {{1,-80,70};}; % Cross Range Limitation {True/False, CR_Min, CR_Max}

filt_by_coh_list = {{0,-inf};}; % Filter by Coherence {True/False, COH_Min}

filt_by_maxDisp_list = {{0,-inf,inf};}; % Filter by Maximum Displacement {True/False, dDNeg_max, dDPos_max}

filt_by_aoi_list = {{1,1,[0]};}; % Filter by Area of Interest {True/False, Number of AoI, isCircle True/False}

time_select_list = {{0, datetime(…),datetime(…)};}; % Filter by Time {True/False, T_Start, T_End}

time_select_zoom_list = {{0, datetime(…),datetime(…)};}; % Filter by Time (Zoom for psi2timeseries function)

filt_by_aoi_zoom_list = {{1,4,[0]};}; % Filter by Area of Interest (Zoom for psi2timeseries function)

for p_i = 1:length(proj_list)

    name2proj = proj_list{p_i};
    path2proj = fullfile(file_dir,'D00_sample_data','real',name2proj);

    %% Processing: From Raw Data to SLC
    filt_by_rng  = filt_by_dist_list{p_i};
    filt_by_azi  = filt_by_azi_list{p_i};
    filt_by_asi  = filt_by_asi_list{p_i};
```

```
    cascade_MIMO_01_raw2slc(path2proj,filt_by_rng,filt_by_azi,filt_by_asi);

    %% Processing: From SLC Data to PSI
    % Settings for Geometrical Filtering
    filt_by_aoi = filt_by_aoi_list{p_i};
    filt_by_rng = filt_by_dist_list{p_i};
    filt_by_lr  = filt_by_lr_list{p_i};
    filt_by_azi = filt_by_azi_list{p_i};

    % Settings for Statistical Filtering
    filt_by_asi = filt_by_asi_list{p_i};
    filt_by_coh = filt_by_coh_list{p_i};
    filt_by_maxDisp = filt_by_maxDisp_list{p_i};

    % Settings for Temporal Filtering
    filt_by_time = time_select_list{p_i};

    cascade_MIMO_02_slc2psi(path2proj,...
                            filt_by_rng,...
                            filt_by_lr,...
                            filt_by_azi,...
                            filt_by_asi,...
                            filt_by_coh,...
                            filt_by_maxDisp,...
                            filt_by_time,...
                            filt_by_aoi);


    %% Processing: From PSI to Coordinate Components
    % Settings for Temporal Filtering
    filt_by_asi = filt_by_asi_list{p_i};
    filt_by_time = time_select_zoom_list{p_i};
    create_aoi = filt_by_aoi_zoom_list{p_i}{2};

    cascade_MIMO_03_psi2timeseries(path2proj, filt_by_time, filt_by_asi, create_aoi);

end
```

For the script to be working the following files need to be created/copied in the correct folders:

1.) The raw data (*.bin and *.json) in:

    D00_sample_data\real\<project_name>\01_Raw_Radar_Data\

2.) Parameter files
    - header.m — same for all TIDEP-01012 and Configurations
    - module_param_1Chirp.m — same for all TIDEP-01012 but only for $N_{Chirps} = 1$
    - phaseMismatchCalibration.mat — different for each TIDEP-01012

    in:

    D00_sample_data\real\<project_name>\00_Parameter_Files\

    The required files for each sensor are stored for convenience in
    D01_documentation\TIDEP-01012_03_Processing_MIMO\TIDEP_01012_<sensor>

3.) A matlab file named <project_name>.m, with details about chirp and acquisition in:

D00_sample_data\real\<project_name>\

```
%% Path to Input File
file_dir = fileparts(mfilename('fullpath'));
path_to_slc = fullfile(file_dir,'02_SLC_Radar_data');

%% Load all SLCs in given folder
[x_axis, y_axis, cplx, coh, time_properties] = load_slc_files(path_to_slc);

%% Position and Orientation
% Position of the Radar Instrument (for coregistration with other sensors)
% in a common Coordinate Reference System (CRS)
radar_position =   [759984.755,...  % East [m]
                    195927.094,...  % North [m]
                    553.568];       % Height [m]
radar_orient =     [168.5943,...    % Azimuth [degree]
                    69.7854,...    % Elevation [degree]
                    90.000];        % Rotation [degree]

%% Chirp Configuration
c0              = physconst('LightSpeed'); % [m/s]
t_adcs          = 10 * 10^-6; % [s]
smpl_rate       = 8493 * 10^3; % [Hz]
num_ADC_smpl    = 512; % [s]
num_antenna     = 86; % Number of virtual antennas [-]
length_antenna  = 3; % Length of one antenna [lambda]
t_smpl          = num_ADC_smpl / smpl_rate; % [s]
slpe_hz_s       = 4.9728 * 10^12; % [Hz/s]
chrp_bw         = t_smpl * slpe_hz_s; % [Hz]
f0              = 77 * 10^9 + ( t_adcs * slpe_hz_s ); % [Hz]
fc              = f0 + chrp_bw / 2; % [Hz]
lambda          = c0 / fc; % [m]
rng_res         = c0 / (2 * chrp_bw); % [m]

%% Temporal Acquisition Properties
data_hz = 100; % Data Acquisition Rate [Hz]
speed_of_acquisition = 1/data_hz; % Speed of Data Acquisition [s]

ti_blk = 240; % Duration of one Acquisition Block [s]
ti_str = datetime(2022,09,14,11,12,32,000); % Time of first Acquisition [Datetime]

timestamp_rel = [];
ti_blk_ct = 0; % Counter for time_block

act_size = zeros([max(time_properties.set_of_file_i),1]);
set_i = 0;
for fi = 1:length(time_properties.no_of_file_i)
    if fi==1 || time_properties.set_of_file_i(fi)-time_properties.set_of_file_i(fi-1)==1
        set_i = set_i+1;
        act_size(set_i) = time_properties.length_of_file_i(fi);
    elseif time_properties.set_of_file_i(fi)-time_properties.set_of_file_i(fi-1)==0
        act_size(set_i) = act_size(set_i)+time_properties.length_of_file_i(fi);
    else
        error('Not defined cased.');
    end
end

for fi = 1:length(time_properties.no_of_file_i)
    no_files_fi = time_properties.length_of_file_i(fi);
    if time_properties.no_of_file_i(fi)==1
        ti = 1:no_files_fi; % Skipped first acquisition in cascade_MIMO_01_raw2slc (startValidFrame == 2)
    else
        ti = 0:no_files_fi-1;
    end
    ti = speed_of_acquisition * ti;

    if  fi>1 && time_properties.set_of_file_i(fi)-time_properties.set_of_file_i(fi-1)
        ti_blk_ct = ti_blk * (time_properties.set_of_file_i(fi)-1);
    end

    timestamp_rel(end+1:end+length(ti)) = ti_blk_ct + ti;

    ti_blk_ct = timestamp_rel(end) + speed_of_acquisition;
end

timestamp_rel = seconds(timestamp_rel);
timestamp_abs = timestamp_rel + ti_str;
```

Radar Position and Orientation [optional]

Chirp Configuration of the Acquisition

Acquisition Frequency

Duration of Frameset and Acquisition Start

4.) The (intermediate) results will be stored in subfolders:
D00_sample_data\real\<project_name>\<subfolder_name>