NetSim - MATLAB Interfacing for UAV/Drone/Flying Adhoc, network simulations.

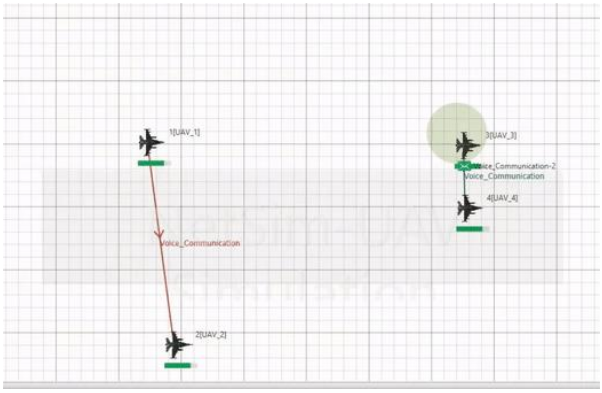
Applicable Versions	**NetSim Pro**	**NetSim Standard**	
Applicable Releases	**v12.2**		
MATLAB Version			**R2019b or above**
MATLAB Toolbox			MATLAB, Simulink, Robotics and System Toolbox
FE Project			Robotics System Toolbox UAV Library
Visual Studio			Community Edition

Contents

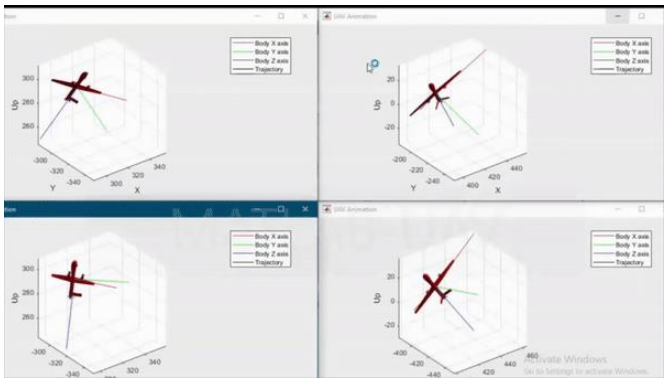
Objective

In this article, we are going to explain how users can simulate UAV device in NetSim by interfacing with MATLAB's Simulink.

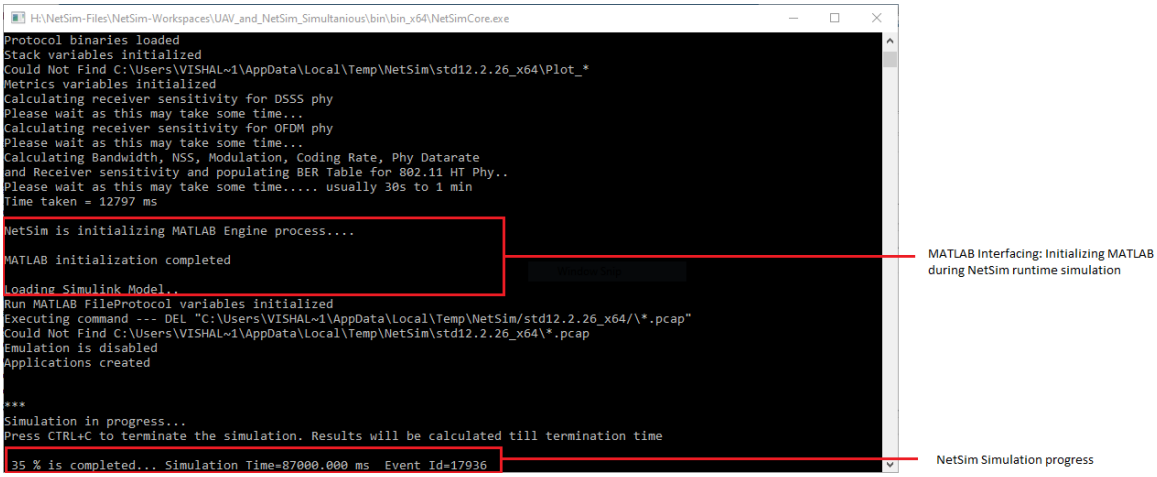
3D View in MATLAB and 2D View in NetSim



2D- Animation in NetSim



3D Animation in MATLAB



NetSim Simulation Window

NetSim - Simulink Interfacing

Upon interfacing NetSim with MATLAB the following tasks are performed during simulation start:

- MATLAB Engine process is initialized
- MATLAB Desktop window is loaded
- SIMULINK Model is loaded

Upon simulating a network created in NetSim the following tasks are performed periodically:

- SIMULINK Model is simulated
- SIMULINK Model is paused
- NetSim reads the data generated by SIMULINK from MATLAB workspace
- Updates the co-ordinates of the devices.

During the Simulation, the SIMULINK Model is started and paused several times for NetSim and SIMULINK simulations to run synchronously. The X, Y and Z coordinates obtained from SIMULINK are read from MATLAB workspace and given as input to NetSim's Mobility model. In this example, coordinates are taken every one second and updated to the device mobility.

Output/Metrics specific to this example

- NetSIm Animation- Mobility of the devices configured in NetSim is given as input from MATLAB

Modifications done to NetSim Source codes:

Project: Mobility
Files:

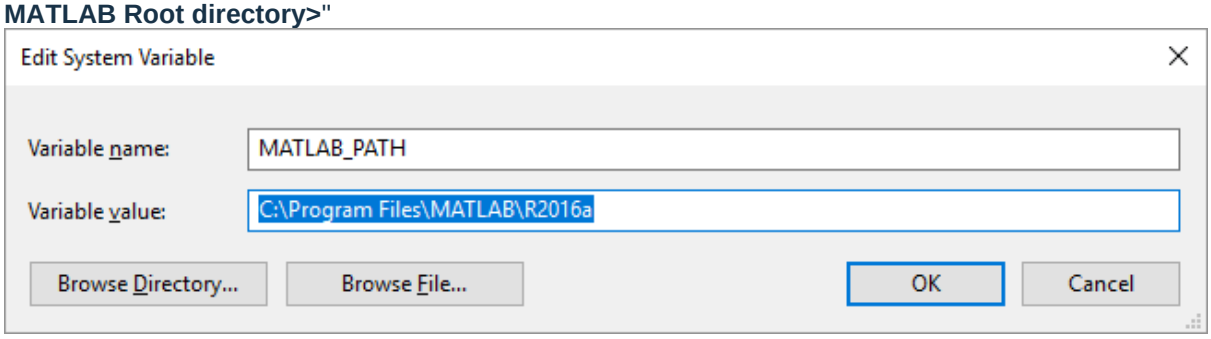
- Mobility.c,
- Mobility.h,
- Added - UAVBasedMobility.c
- Mobility.vcxproj (Project file)

Sections of source code modified

- Mobility.c
  - fn_NetSim_Mobility_Init(): call to init_uav() function
  - fn_NetSim_Mobility_Run(): Call to uav_run() function
  - fn_NetSim_Mobility_Finish(): Call to finish_uav() function
- Mobility.h
  - MATLAB Engine variable - Used to initiate and interact with MATLAB Engine process
- Mobility.vcxproj - This is a Visual Studio project file used to load and manage the source codes related to the Mobility in NetSim
  - path to MATLAB application
  - path to MATLAB include directory
  - path to MATLAB lib directory
  - information related to dependent MATLAB library files
- UAVBasedMobility.c
  - init_uav(): Initializes MATLAB, Loads SIMULINK Model, starts and pauses SIMULINK simulation , and initializes the UAV devices in MATLAB to start simulation along with NetSim's simulation.
  - uav_run(): Starts NetSim and MATLAB simulation simultaneously and gets the co-ordinates from MATLAB workspace for every step size set in NetSim.
  - uavcorr(): Function to get co-ordinates from MATLAB.

Procedure to setup MATLAB for this example

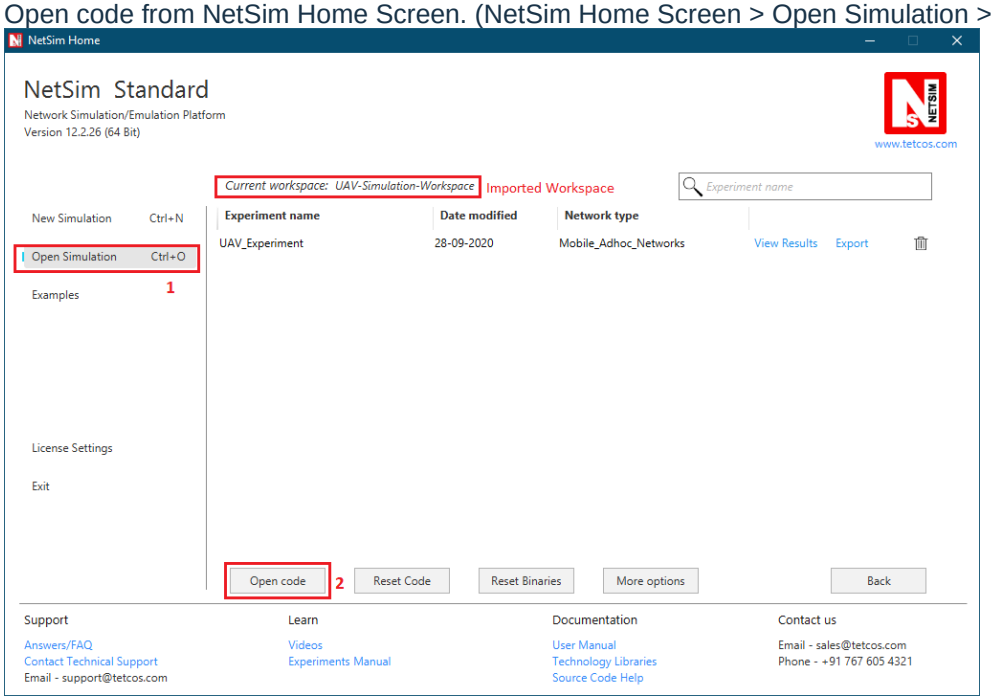
- Create a system environment variable with name as "**MATLAB_PATH**" and value as "**<path of MATLAB Root directory>**"



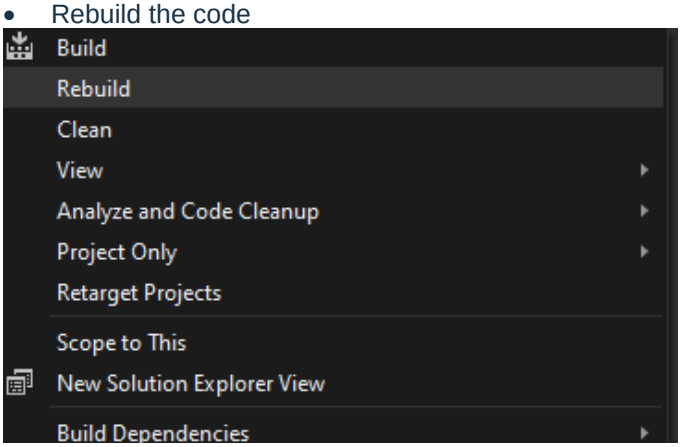
Note: The procedure to create an environment variable and the path of the MATLAB root directory will vary based on the Windows OS version and the MATLAB software version respectively.

Procedure to setup NetSim for this example

- Download the attachment containing both NetSim Workplace and MATLAB FIles
- Import the workspace to NetSim. *<Article on how to import workspace in NetSim>*
- Place MATLAB files in the desired location of your wish. Make sure that the location is both readable and writeable
- Replace GenerlProperty.xml file present in NetSim-Files folder in the attachment in <NetSim-Installation-Directory>/Docs/XML folder.
- Open code from NetSim Home Screen. (NetSim Home Screen > Open Simulation > Open code)



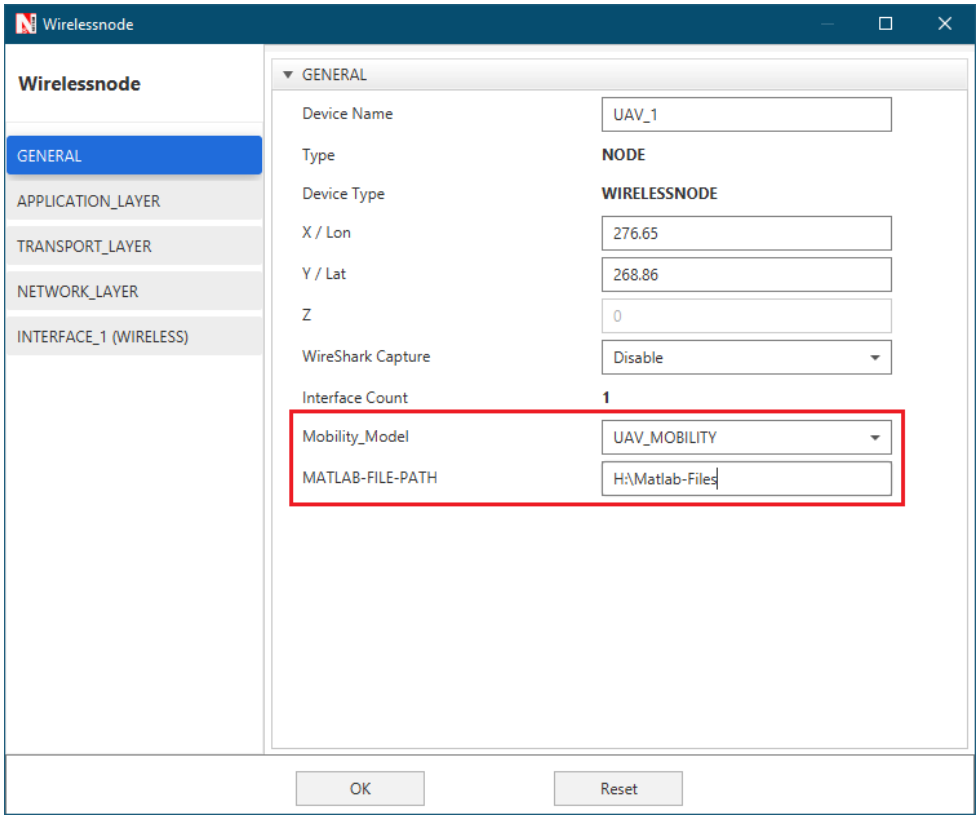
- Rebuild the code



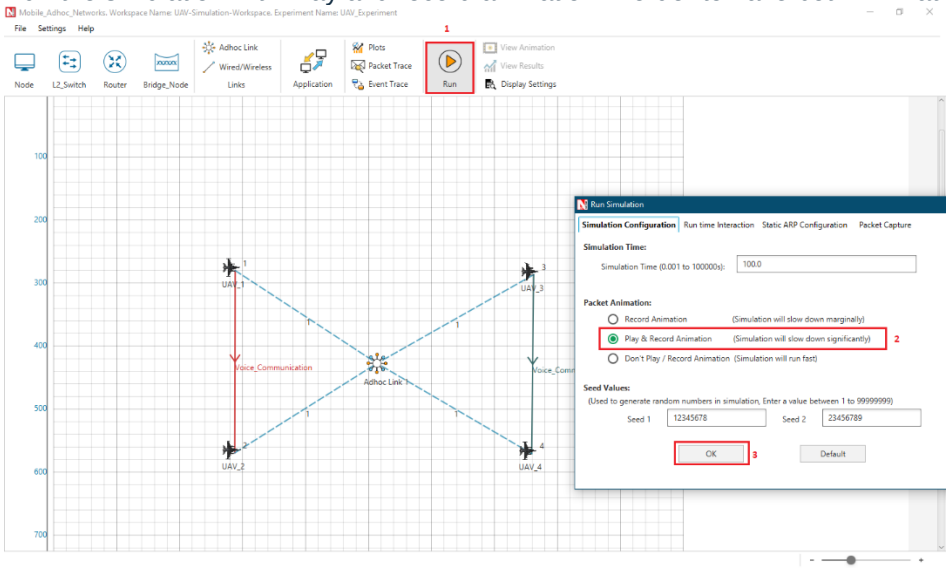
Running the NetSim scenario with UAV Based Mobility

- Before opening Example make sure that you have replaced the XML file in NetSim Installation directory mentioned above and then Open Example saved in the workspace.

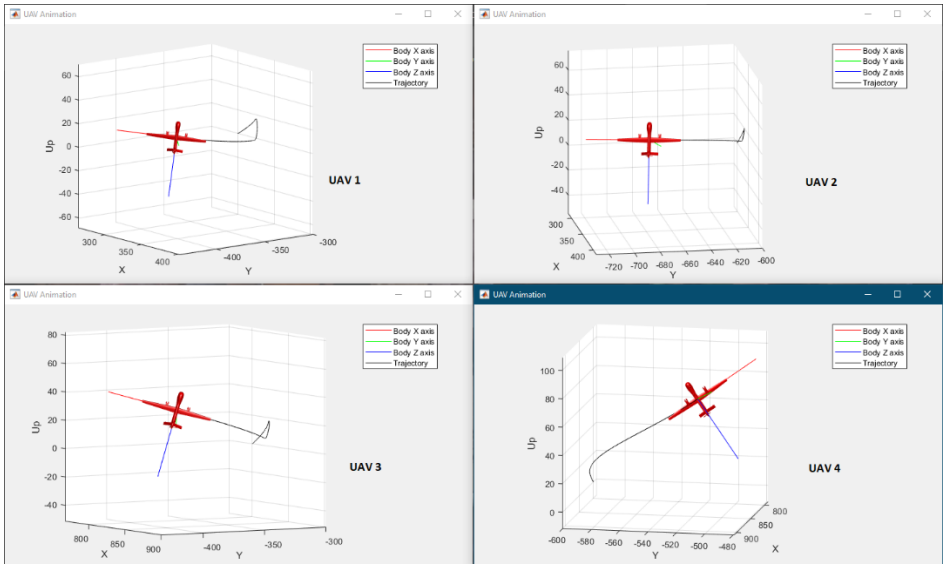
- Make sure that all devices are UAV Mobility enabled and update path to MATLAB files that you downloaded with the attachement



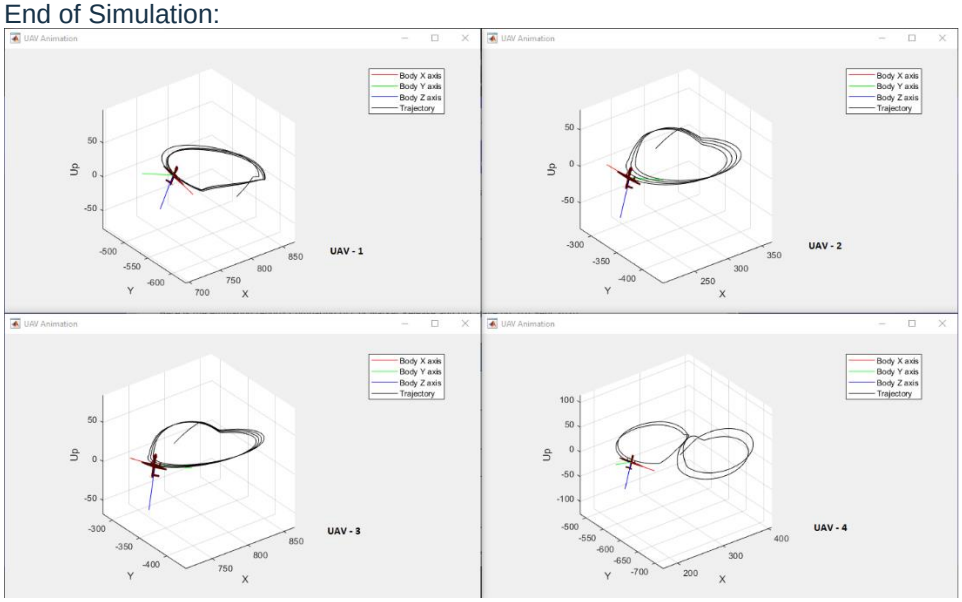
- Run the simulation with Play and record animation in order to have both Animations simultaneous



- MATLAB Animation



End of Simulation:



Code modifications in NetSim

A new file UAVBasedMobility.c is added to the **Mobility** Project, which contains the following source code:

```
#include "main.h"
#include "Mobility.h"
#include "Animation.h"
double* uavcorr(char* id);
char* matlabloc;

/*init_uav() function is to initialize MATLAB Engine and start UAVs*/
void init_uav()
{
	static int nouav = 1;	// Declared as static, since we want it to be
declared and changed only once
	char buf[100] = "cd ";
	char wp[100];
	char sim[100] = "opSimulink";
```

```
	strcpy(wp, matlabloc);
	strcat(buf, wp);
	if (nouav)                              // This will run only at the 1st
time
	{

		//MATLAB/SIMULINK INTERFACING
		fprintf(stderr, "\nNetSim is initializing MATLAB Engine
process....\n");
		if (!(ep = engOpen(NULL))) {
			MessageBox((HWND)NULL, (LPCWSTR)"Can't start MATLAB
engine",(LPCWSTR)"MATLAB_Interface.c", MB_OK);
			fprintf(stderr, "\nMATLAB Initialization Failed\nPress any key
to proceed without MATLAB...\n");
			_getch();
		}
		else
		{
			engEvalString(ep, "desktop");
			engEvalString(ep, buf); //Update user-path
			fprintf(stderr, "\nMATLAB initialization completed\n");
			fprintf(stderr, "\nLoading Simulink Model..");
			engEvalString(ep, sim);
		}
		//MATLAB/SIMULINK INTERFACING
		nouav = 0;
	}
}

/*This function is used to receive co-ordinates from MATLAB during run time*/
void uav_run()
{
	MOBILITY_VAR* pstruMobilityVar = (MOBILITY_VAR*)NETWORK-
>ppstruDeviceList[pstruEventDetails->nDeviceId - 1]->pstruDeviceMobility-
>pstruMobVar;//Define Mobility variable
	double dPresentTime = pstruMobilityVar->dLastTime;

	memcpy(NETWORK->ppstruDeviceList[pstruEventDetails->nDeviceId - 1]-
>pstruDeviceMobility->pstruCurrentPosition,
		NETWORK->ppstruDeviceList[pstruEventDetails->nDeviceId - 1]-
>pstruDeviceMobility->pstruNextPosition,
		sizeof * NETWORK->ppstruDeviceList[pstruEventDetails->nDeviceId -
1]->pstruDeviceMobility->pstruCurrentPosition);

	if (pstruMobilityVar->dLastTime + pstruMobilityVar->dPauseTime * 1000000 <
pstruEventDetails->dEventTime + 1000000)	//Everytime Mobility being called
	{
		double* coordinates;			// Pointer for array of X and Y
coordinates
		coordinates = uavcorr(pstruEventDetails->nDeviceId);//Get
coordinates from matlab
		if (coordinates != NULL)
		{
			NETWORK->ppstruDeviceList[pstruEventDetails->nDeviceId - 1]-
>pstruDeviceMobility->pstruNextPosition->X = coordinates[0];	// Update the
coordinates in Network stack
			NETWORK->ppstruDeviceList[pstruEventDetails->nDeviceId - 1]-
>pstruDeviceMobility->pstruNextPosition->Y = coordinates[1];
```

```
                  NETWORK->ppstruDeviceList[pstruEventDetails->nDeviceId - 1]-
>pstruDeviceMobility->pstruNextPosition->Z = coordinates[2];
                  free(coordinates);               // Free memory of pointer
            }

            //store the last time
            pstruMobilityVar->dLastTime = pstruEventDetails->dEventTime + 100;
                  // Update Last time since we want to match timings with MATLAB
      }
      //update the device position
      memcpy(NETWORK->ppstruDeviceList[pstruEventDetails->nDeviceId - 1]-
>pstruDevicePosition,
            NETWORK->ppstruDeviceList[pstruEventDetails->nDeviceId - 1]-
>pstruDeviceMobility->pstruCurrentPosition,
            sizeof * NETWORK->ppstruDeviceList[pstruEventDetails->nDeviceId -
1]->pstruDevicePosition);

      mobility_pass_position_to_animation(pstruEventDetails->nDeviceId,
            pstruEventDetails->dEventTime,
            DEVICE_POSITION(pstruEventDetails->nDeviceId));

      //Add event for next point
      pstruEventDetails->dEventTime += (1* SECOND);
      fnpAddEvent(pstruEventDetails);
      pstruEventDetails->dEventTime -= (1 * SECOND);
}

double* uavcorr(int id)
{
      double* coordinates;
      char buf[100];
      mxArray* xmat = NULL;
      mxArray* ymat = NULL;
      mxArray* zmat = NULL;
      double* xcor = NULL;
      double* ycor = NULL;
      double* zcor = NULL;
      if (id == 1)
            engEvalString(ep,
"set_param('UAV1','SimulationCommand','continue');set_param('UAV1','SimulationComm
and','pause');");
      else if (id == 2)
            engEvalString(ep,
"set_param('UAV2','SimulationCommand','continue');set_param('UAV2','SimulationComm
and','pause');");
      else if (id == 3)
            engEvalString(ep,
"set_param('UAV3','SimulationCommand','continue');set_param('UAV3','SimulationComm
and','pause');");
      else
            engEvalString(ep,
"set_param('UAV4','SimulationCommand','continue');set_param('UAV4','SimulationComm
and','pause');");

      engEvalString(ep, "[xa,c]=size(North)");
      engEvalString(ep, "x_out = North(xa, :)");
      engEvalString(ep, "[ya, c] = size(East)");
      engEvalString(ep, "y_out = East(ya, :)");
      engEvalString(ep, "[za, c] = size(Height)");
```

```
        engEvalString(ep, "z_out = Height(za, :)");
        xmat = engGetVariable(ep, "x_out");
        ymat = engGetVariable(ep, "y_out");
        zmat = engGetVariable(ep, "z_out");
        xcor = mxGetPr(xmat);
        ycor = mxGetPr(ymat);
        zcor = mxGetPr(zmat);
        coordinates = (double*)malloc(3 * sizeof * coordinates);
        coordinates[0] = xcor[0];
        coordinates[1] = ycor[0];
        coordinates[2] = zcor[0];
        return (coordinates);
}Generic
```

MATLAB Code: OpSimulink.m

```
% This function is used to initialize and start Simulink model called in NetSim-
init_uav() function.

% Initiating UAV 1
model='UAV1';
load_system(model);
set_param(model,'SimulationCommand','start')
set_param(model,'SimulationCommand','pause')

% Initiating UAV 2
model1='UAV2';
load_system(model1);
set_param(model1,'SimulationCommand','start')
set_param(model1,'SimulationCommand','pause')

% Initiating UAV 3
model2='UAV3';
load_system(model2);
set_param(model2,'SimulationCommand','start')
set_param(model2,'SimulationCommand','pause')

% Initiating UAV 4
model3='UAV4';
load_system(model3);
set_param(model3,'SimulationCommand','start')
set_param(model3,'SimulationCommand','pause')
```