

Heterogeneous LEACH for WSN

Software: NetSim Standard v13.0 64-bit, Visual Studio 2019, MATLAB 64-bit

Project Download Link:

[https://github.com/NetSim-TETCOS/Heterogeneous LEACH for WSN v13.0/archive/refs/heads/main.zip](https://github.com/NetSim-TETCOS/Heterogeneous_LEACH_for_WSN_v13.0/archive/refs/heads/main.zip)

Follow the instructions specified in the following link to download and setup the Project in NetSim:

<https://support.tetcos.com/en/support/solutions/articles/14000128666-downloading-and-setting-up-netsim-file-exchange-projects>

Introduction

In Wireless Sensor Networks energy efficiency plays a crucial role as the sensors are generally battery powered. Hierarchical routing protocols can be used to overcome this constraint.

LEACH is a hierarchical protocol in which most nodes transmit to cluster heads, and the cluster heads aggregate and compress the data and forward it to the base station (sink). Each node uses a stochastic algorithm at each round to determine whether it will become a cluster head in this round. LEACH assumes that each node has a radio powerful enough to directly reach the base station or the nearest cluster head, but that using this radio at full power all the time would waste energy.

Heterogeneous LEACH involves a network with sensor nodes of different energy levels. Clusters are formed periodically, and cluster heads are elected. Nodes send packets either to the cluster head or to the sinknode based on whichever is located near.

Heterogeneous LEACH in NetSim with MATLAB Interfacing

Heterogeneous LEACH is implemented in NetSim by Interfacing with MATLAB for the purpose of mathematical calculation. The sensor coordinates and remaining energy are fed as input to MATLAB. Heterogeneous LEACH algorithm that is implemented in MATLAB is used to dynamically form clusters and elect cluster heads.

From MATLAB the number of clusters, cluster head id's and cluster membership is retrieved to perform routing in NetSim.

All the above steps are performed periodically and can be defined as per the implementation. Each time a node dies, the algorithm is invoked to perform clustering excluding the dead nodes.

LEACH_HETERO.m file contains the code for mathematical calculations done in MATLAB

- `fn_NetSim_LEACH_HETERO_form_cluster();` //This function updates the information obtained from MATLAB to identify clusters and cluster heads formed using LEACH protocol.
- `fn_NetSim_LEACH_HETERO_Init();` //This function initializes the parameters specific to LEACH protocol and identifies the number of sensors that are alive at any instance of simulation.
- `fn_NetSim_LEACH_HETERO_CheckIfCH();` //This function is used to check whether a node is a cluster head or a normal sensor node.

Static Routing

Static Routing is defined in such a way that the sensors send packets to its cluster head. Once packet arrives at the cluster head it is forwarded to the destination or the sinknode.

Steps to simulate

1. Add the following MATLAB install directory path in the Environment PATH variable
<MATLAB_INSTALL_DIRECTORY>\bin\win64
For eg: C:\Program Files\MATLAB\R2020a\bin\win64

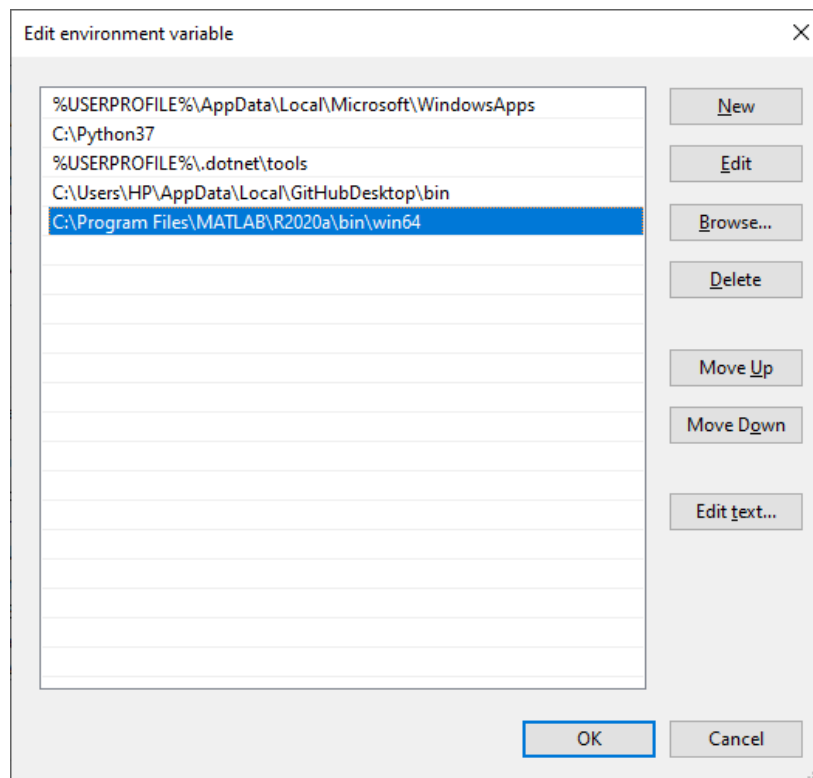


Figure 1: Environment variable PATH

Note: If the machine has more than one MATLAB installed, the directory for the target platform must be ahead of any other MATLAB directory (for instance, when compiling a 64-bit application, the directory in the MATLAB 64-bit installation must be the first one on the PATH).

2. Open Command prompt as admin and execute the command "matlab -regserver". This will register MATLAB as a COM automation server and is required for NetSim to start MATLAB automation server during runtime.
3. Place **LEACH_HETERO.m** present in the MATLAB_Code folder inside the root directory of MATLAB. For Example: "**C:\Program Files\MATLAB\R2016a**".
4. Open the Source codes in Visual Studio by going to Your work-> Workspace Options and

Clicking on Open code button in NetSim Home Screen window.

5. Under the DSR project in the solution explorer you will be able to see that **MATLAB_Interface.c** and **LEACH_HETEROGENEOUS.c** files which contain source codes related to interactions with MATLAB and handling clustering in NetSim, respectively.
6. Right click on the **Solution** project in the solution explorer and select Rebuild.

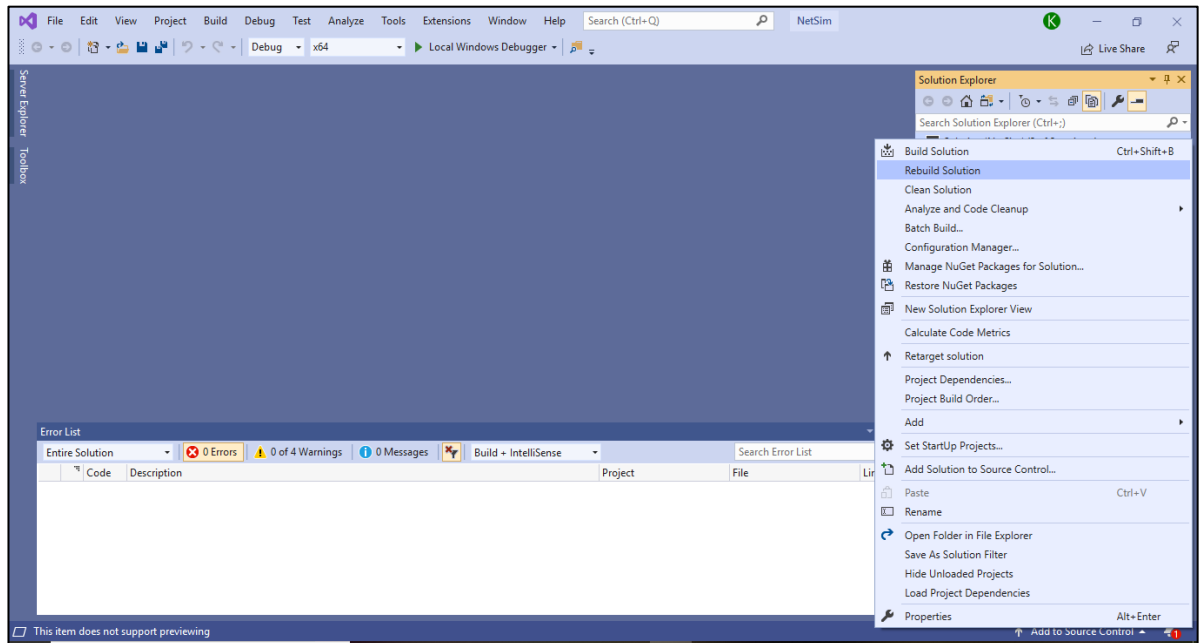


Figure 2: Screen shot of NetSim project source code in Visual Studio

7. Upon successful build modified Dll files gets automatically updated in the directory containing NetSim binaries.

Example

1. Run NetSim as Administrative mode.
2. The LEACH_HETERO_WORKSPACE comes with a sample network configuration that are already saved. To open this example, go to Your work in the Home screen of NetSim and click on the LEACH_HETEROGENEOUS example from the list of experiments.
3. The network scenario consists of 100 sensors deployed randomly in a 50x50m grid environment with a sink node placed in the centre.

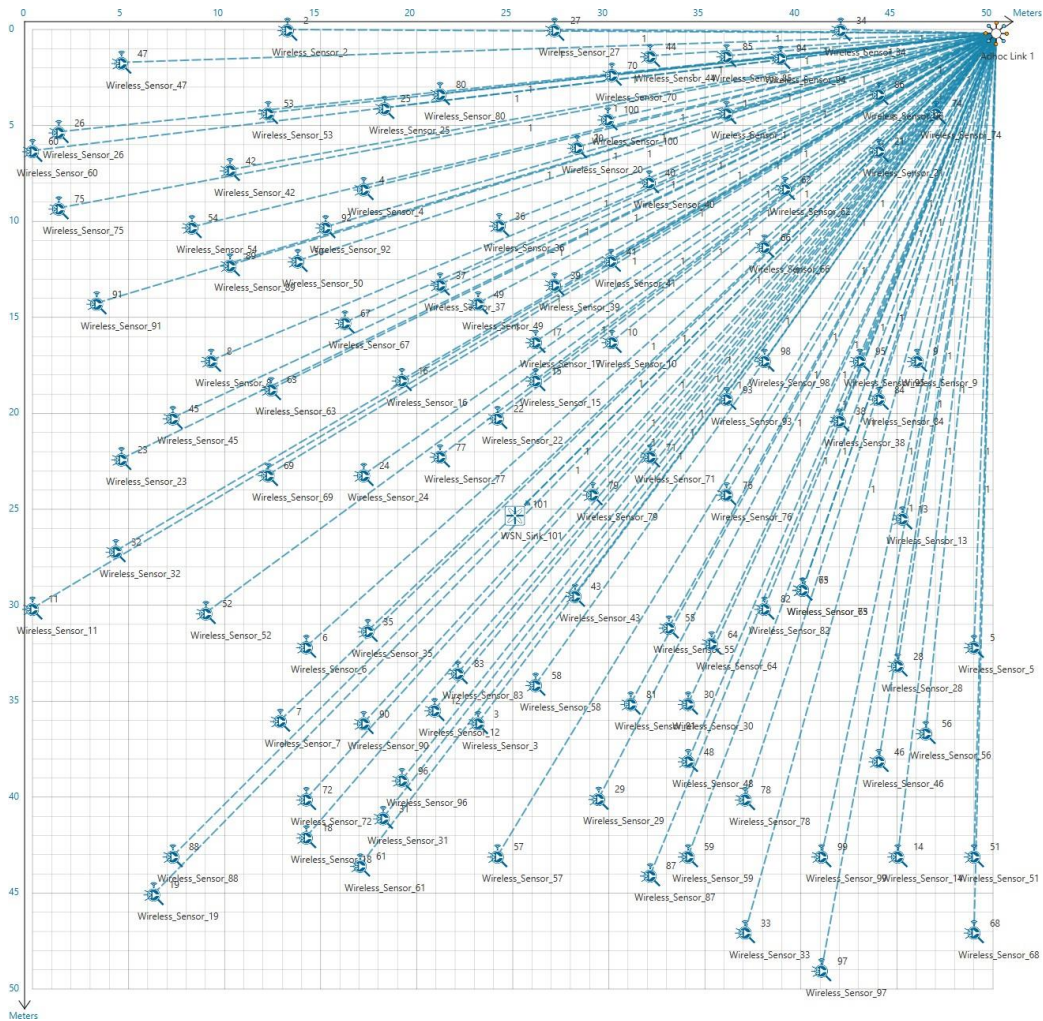


Figure 3: Network scenario consists of 100 sensors deployed randomly

4. Run simulation and press any key to continue. NetSim simulation console will show the following message in the console “Waiting for NetSim MATLAB Interface to connect...”
5. Click on **Options** from NetSim design window and click on **Open MATLAB Interface** as shown in below given screenshot.

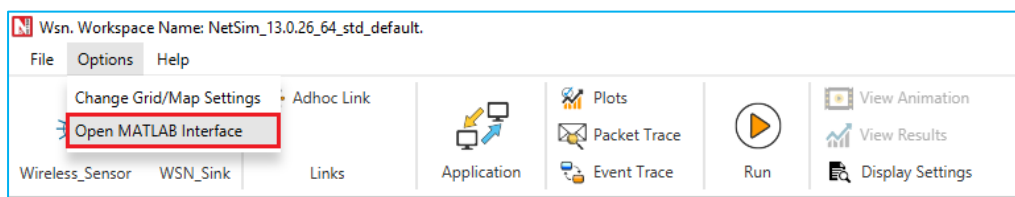


Figure 4: Open MATLAB Interface from NetSim design window

6. It will open the popup related MATLAB Interfacing, Click on **OK**.

Results and discussion: You will observe that as the simulation starts, and the plots will be displayed in MATLAB shown below:

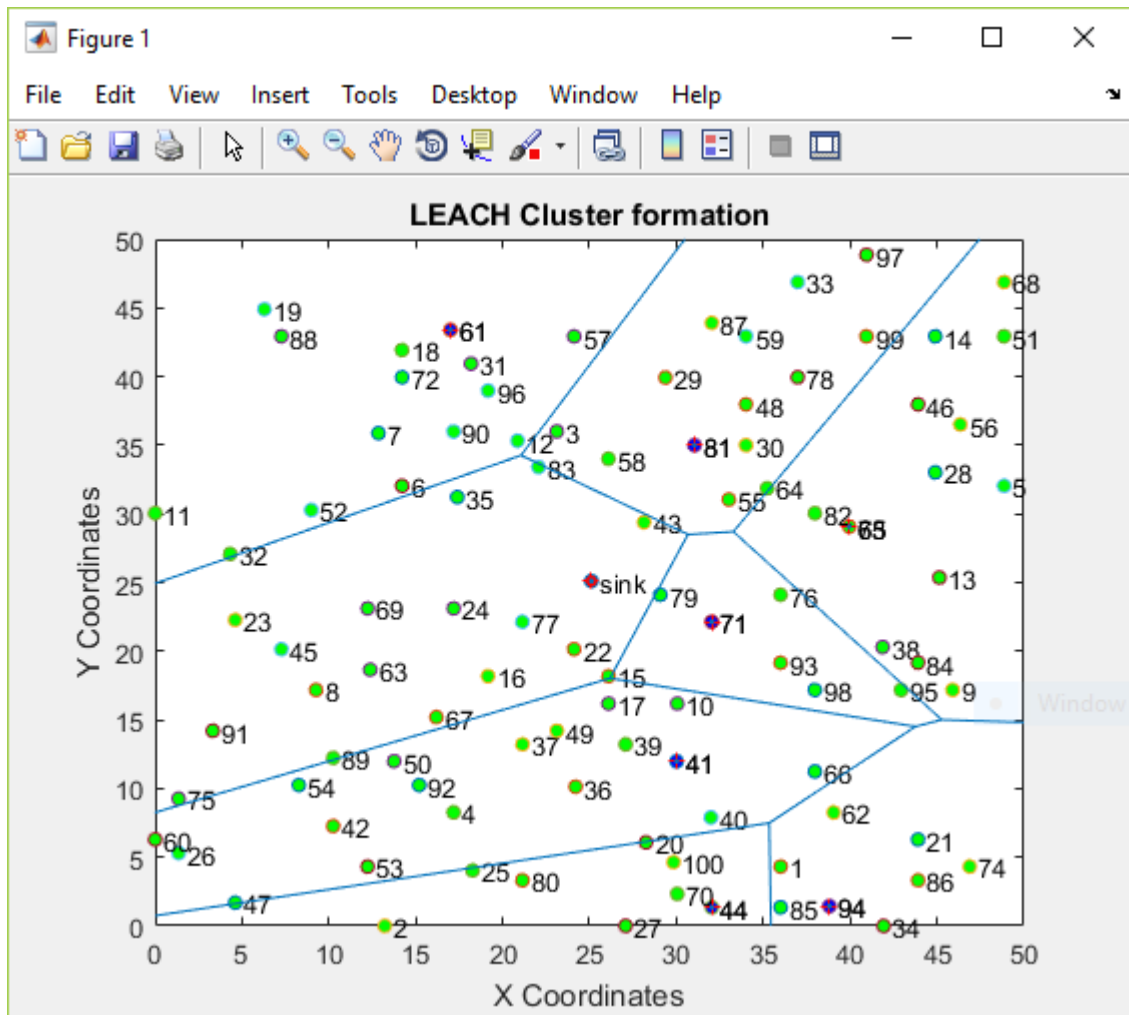


Figure 5: LEACH Cluster formation in MATLAB

The above plot contains the nodes that are part of the network in NetSim. All sensor nodes are initially alive. Sink node that is highlighted in the center and the nodes marked in blue act as cluster heads.

The plot is further divided into different regions based on the location of the cluster heads using a Voronoi diagram.

The clusters and cluster heads are calculated periodically and whenever one or more node runs out of energy and dies.