LEACH Protocol Implementation in MATLAB by Mohammad Hossein Homaei

Submitted By:

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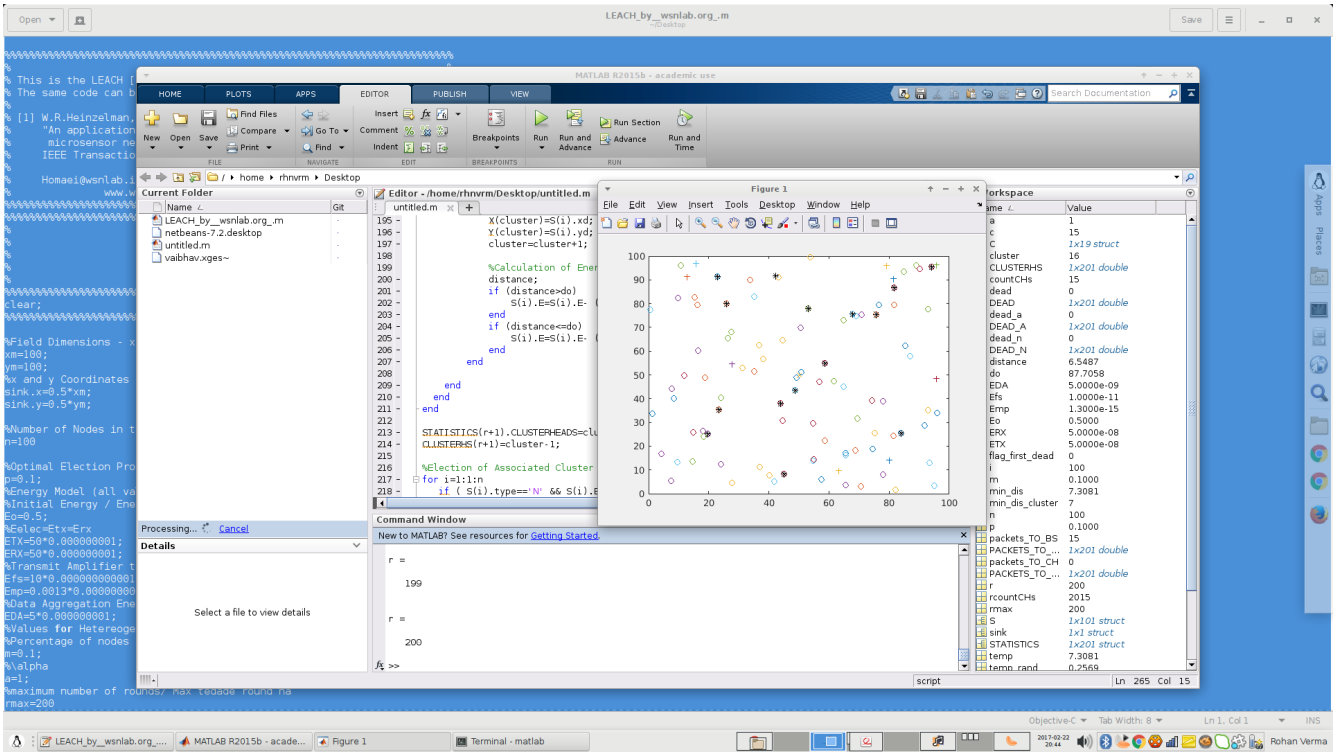
Screenshot



Code

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%                                                                %
% This is the LEACH [1] code we have used.                       %
% The same code can be used for FAIR if m=1                      %
%                                                                %
% [1] W.R.Heinzelman, A.P.Chandrakasan and H.Balakrishnan,       %
%     "An application-specific protocol architecture for wireless  %
%      microsensor networks"                                     %
%     IEEE Transactions on Wireless Communications, 1(4):660-670,2002  %
%                    Mohammad Hossein Homaei                     %
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%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%                                                                %
%                        LEACH Protocol                          %
%                                                                %
%                  By: Mohammad Hossein Homaei                   %
%                        homaei@wsnlab.ir                        %
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
clear;
%%%%%%%%%%%%%%%%%%%%%%%%%%%% PARAMETERS %%%%%%%%%%%%%%%%%%%%%%%%%%%%

%Field Dimensions - x and y maximum (in meters)/ Tarife Size mohite shabake(m)
xm=100;
ym=100;
%x and y Coordinates of the Sink  /
sink.x=0.5*xm;
sink.y=0.5*ym;

%Number of Nodes in the field  / Tedade Node haye shabake
n=100

%Optimal Election Probability of a node to become cluster head/ Ehtemale Entekhab Node be onvane Cluster Head
p=0.1;
%Energy Model (all values in Joules)/ Energy ha bar hasbe Joule
%Initial Energy / Energy Avaliye
Eo=0.5;
%Eelec=Etx=Erx
ETX=50*0.000000001;
```

```
ERX=50*0.000000001;
%Transmit Amplifier types / Ghodrate Ersal
Efs=10*0.000000000001;
Emp=0.0013*0.000000000001;
%Data Aggregation Energy/ Energy Masrafi Tajmie Dade
EDA=5*0.000000001;
%Values for Hetereogeneity
%Percentage of nodes than are advanced
m=0.1;
%\alpha
a=1;
%maximum number of rounds/ Max tedade round ha
rmax=200
%%%%%%%%%%%%%%%%%%%%%%%% END OF PARAMETERS %%%%%%%%%%
%%%%%%%%%%%%
%Computation of do/
do=sqrt(Efs/Emp);
%Creation of the random Sensor Network/ Tolide Randome shabake
figure(1);
for i=1:1:n
    S(i).xd=rand(1,1)*xm;
    XR(i)=S(i).xd;
    S(i).yd=rand(1,1)*ym;
    YR(i)=S(i).yd;
    S(i).G=0;
    %initially there are no cluster heads only nodes/ Dar ebteda hich Cluster Head i mojud nist
    S(i).type='N';

    temp_rnd0=i;
    %Random Election of Normal Nodes/ Entekhabe Tasadofi Node ha
    if (temp_rnd0>=m*n+1)
        S(i).E=Eo;
        S(i).ENERGY=0;
        plot(S(i).xd,S(i).yd,'o');
        hold on;
    end
    %Random Election of Advanced Nodes/ Entekhab Tasadofie CH ha
    if (temp_rnd0<m*n+1)
        S(i).E=Eo*(1+a)
        S(i).ENERGY=1;
        plot(S(i).xd,S(i).yd,'+');
        hold on;
    end
end
S(n+1).xd=sink.x;
S(n+1).yd=sink.y;
plot(S(n+1).xd,S(n+1).yd,'x');
```

```
%First Iteration
figure(1);

%counter for CHs/ Tedade Cluster Head ha
countCHs=0;
%counter for CHs per round/ Tedade CH haye har Round
rcountCHs=0;
cluster=1;

countCHs;
rcountCHs=rcountCHs+countCHs;
flag_first_dead=0;

for r=0:1:rmax
   r

  %Operation for epoch/ Formule entekhabe CH
  if(mod(r, round(1/p) )==0)
    for i=1:1:n
       S(i).G=0;
       S(i).cl=0;
    end
  end

hold off;

%Number of dead nodes/ Tedade Node haye morde dar kol
dead=0;
%Number of dead Advanced Nodes/ Tedade Node haye CH morde
dead_a=0;
%Number of dead Normal Nodes/ Tedade Node haye morde mamuli
dead_n=0;

%counter for bit transmitted to Bases Station and to Cluster Heads/ Tedade packet haye ersali be BS
packets_TO_BS=0;
packets_TO_CH=0;
%counter for bit transmitted to Bases Station and to Cluster Heads /Tedade packet haye Ersali be BS
dar har round
%per round
PACKETS_TO_CH(r+1)=0;
PACKETS_TO_BS(r+1)=0;

figure(1);

for i=1:1:n
   %checking if there is a dead node/ Check kardane zende budane Node ha
   if (S(i).E<=0)
       plot(S(i).xd,S(i).yd,'red .');
       dead=dead+1;
```

```
        if(S(i).ENERGY==1)
           dead_a=dead_a+1;
        end
        if(S(i).ENERGY==0)
           dead_n=dead_n+1;
        end
        hold on;
    end
    if S(i).E>0
        S(i).type='N';
        if (S(i).ENERGY==0)
        plot(S(i).xd,S(i).yd,'o');
        end
        if (S(i).ENERGY==1)
        plot(S(i).xd,S(i).yd,'+');
        end
        hold on;
    end
end
plot(S(n+1).xd,S(n+1).yd,'x');


STATISTICS(r+1).DEAD=dead;
DEAD(r+1)=dead;
DEAD_N(r+1)=dead_n;
DEAD_A(r+1)=dead_a;

%When the first node dies/ Pas az marge avalin Node
if (dead==1)
    if(flag_first_dead==0)
        first_dead=r
        flag_first_dead=1;
    end
end

countCHs=0;
cluster=1;
for i=1:1:n
   if(S(i).E>0)
   temp_rand=rand;
   if ( (S(i).G)<=0)

 %Election of Cluster Heads/ Entekhabe CH
 if(temp_rand<= (p/(1-p*mod(r,round(1/p)))))
           countCHs=countCHs+1;
           packets_TO_BS=packets_TO_BS+1;
           PACKETS_TO_BS(r+1)=packets_TO_BS;

           S(i).type='C';
```

```
            S(i).G=round(1/p)-1;
            C(cluster).xd=S(i).xd;
            C(cluster).yd=S(i).yd;
            plot(S(i).xd,S(i).yd,'k*');

            distance=sqrt( (S(i).xd-(S(n+1).xd) )^2 + (S(i).yd-(S(n+1).yd) )^2 );
            C(cluster).distance=distance;
            C(cluster).id=i;
            X(cluster)=S(i).xd;
            Y(cluster)=S(i).yd;
            cluster=cluster+1;

            %Calculation of Energy dissipated/  Mohasebe energy masrafi
            distance;
            if (distance>do)
                S(i).E=S(i).E- ( (ETX+EDA)*(4000) + Emp*4000*( distance*distance*distance*distance ));
            end
            if (distance<=do)
                S(i).E=S(i).E- ( (ETX+EDA)*(4000)  + Efs*4000*( distance * distance ));
            end
        end

    end
  end
end

STATISTICS(r+1).CLUSTERHEADS=cluster-1;
CLUSTERHS(r+1)=cluster-1;

%Election of Associated Cluster Head for Normal Nodes/ Entekhabe CH marbute baraye Node haye
mamuli
for i=1:1:n
   if ( S(i).type=='N' && S(i).E>0 )
     if(cluster-1>=1)
       min_dis=sqrt( (S(i).xd-S(n+1).xd)^2 + (S(i).yd-S(n+1).yd)^2 );
       min_dis_cluster=1;
       for c=1:1:cluster-1
          temp=min(min_dis,sqrt( (S(i).xd-C(c).xd)^2 + (S(i).yd-C(c).yd)^2 ) );
          if ( temp<min_dis )
             min_dis=temp;
             min_dis_cluster=c;
          end
       end

       %Energy dissipated by associated Cluster Head/ Mohasebe energy masrafi CH ha
           min_dis;
           if (min_dis>do)
               S(i).E=S(i).E- ( ETX*(4000) + Emp*4000*( min_dis * min_dis * min_dis * min_dis));
           end
```

```
            if (min_dis<=do)
                S(i).E=S(i).E- ( ETX*(4000) + Efs*4000*( min_dis * min_dis));
            end
        %Energy dissipated/ Masrafe energy kol
        if(min_dis>0)
          S(C(min_dis_cluster).id).E = S(C(min_dis_cluster).id).E- ( (ERX + EDA)*4000 );
         PACKETS_TO_CH(r+1)=n-dead-cluster+1;
        end

       S(i).min_dis=min_dis;
       S(i).min_dis_cluster=min_dis_cluster;

   end
  end
end
hold on;

countCHs;
rcountCHs=rcountCHs+countCHs;
end


%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%   STATISTICS    %%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%                                                                  %
%  DEAD  : a rmax x 1 array of number of dead nodes/round
            %
%  DEAD_A : a rmax x 1 array of number of dead Advanced nodes/round
            %
%  DEAD_N : a rmax x 1 array of number of dead Normal nodes/round                    %
%  CLUSTERHS : a rmax x 1 array of number of Cluster Heads/round                    %
%  PACKETS_TO_BS : a rmax x 1 array of number packets send to Base Station/round      %
%  PACKETS_TO_CH : a rmax x 1 array of number of packets send to ClusterHeads/round   %
%  first_dead: the round where the first node died                                %
%                                                                  %
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```