Matlab code for cell tracking.

```matlab
% ********************** user parameters ********************************
loadFiles = true;        % true / false to load new files
trackCells = true;        % true / false to track cell positions

showCells = true;          % true / false to show the cell positions

N = 5;                    % +/- pixel window size
Ntmin = 4;               % min number of time bins per cell
Ntmax = 6;               % max number of time bins per cell
discardFoundPoints = true;    % discard cell positions once a cell is found

discardControl = true;  % true / false to discard control cells from
analysis
ctrlY = 100;             % y position of the controll scafold (to discard)

showDisplacementMap = true; % true / false show displacement map
dmax = 30;               % maximum displacement (color limit)

% ****************** end of user paramets ******************************

discardFoundPoints = logical(discardFoundPoints + (Ntmin ~= Ntmax)); %
force true if Ntmin ~= Ntmax

if loadFiles
    [FileName,PathName] = uigetfile('*.png','MultiSelect','on'); % file
name and dir
    ims = [];                                  % image stack matrix
    for ii = 1 : length(FileName);             % iterate over selected
files
        ims = cat(3,ims,imread([PathName, '\',FileName{ii}])); %
concatenate loaded files
    end
    ims = double(ims);                         % convert matrix to double
end

figure('color','w')                           % create a new white figure
scaff = (175 < ims(:,:,3)).*(ims(:,:,3) < 185); % find scaffolds in image
cells_raw = ims(:,:,2:3:end) == 160;          % find cells in images
if discardControl
    cells = cells_raw; cells(1:ctrlY,:,:) = 0;  % discard control cells
from analysis
end

[fsy,fsx] = find(scaff);                       % find the scaffold point
plot(fsx,fsy,'.k'); axis image;               % show the scaffold
set(gca,'ydir','reverse');                     % show the image in the
typical direction
%imagesc(scaff); axis image; colormap(flipud(gray)) % show the scafold
hold on

if trackCells
    ds = [];                                   % array of cell
displacements
    dmap = nan(size(cells,1),size(cells,2));   % map of cell displacements
    for nt = Ntmax:-1:Ntmin                    % iterate over min number
of time bins / cell
        for ii = N+1 : (size(cells,1) - N)     % iterate over y
            for jj = N+1 : (size(cells,2) - N) % iterate over x
                subcells = cells(ii-N : ii+N , jj-N : jj+N,:);  % find
[2N+1,2N+1] window
                if sum(subcells(:)) == nt      % number of points matches
the time bin requirements
                    xs = zeros(1,nt);          % x array of cell positions
```

```matlab
                    ys = xs;                          % y array of cell positions
                    nCells = 0;                       % number of cells per time
slice
                    fail = false;            % in case no cell is found
                    for kk = 1 : nt                   % iterate over the time
slices
                        [ya,xa] = find(subcells(:,:,kk));    % find cell
positions
                        nCells = max(nCells,length(xa));      % count number
of cells per slice
                        if (nCells == 1) && ~isempty(xa) % if only 1 cell
per slice
                            try
                                xs(kk) = xa + jj - N - 1;    % store cell
trajectory
                                ys(kk) = ya + ii - N - 1;    % store cell
trajectory
                            catch
                                fail = true;     % in case no cell is found
                            end
                        else
                            fail = true;
                        end
                    end
                    if (nCells == 1) && ~isempty(xa) && ~fail  % one and
only one cell is found
                        d = sum(sqrt(diff(xs).^2 + diff(ys).^2)); % total
displacement
                        ds(end+1) = d;            % store in displacements
array
                        dmap(round(mean(ys)),round(mean(xs))) = d;         %
store in displacement mp
                        plot(xs,ys,'linewidth',2,'color',rand(1,3))    %
plot the cell trajectory
                        if discardFoundPoints
                            cells(ii-N : ii+N , jj-N : jj+N,:) = 0; %
discard already counted cells
                        end
                    end
                end
            end
        end
    end
end

if showCells
    cmap = jet(size(cells,3));                        % assign different colors
to the time bins
    for ii = 1 : size(cells,3)
        [y,x] = find(cells_raw(:,:,ii));              % find the cells in
each time bin
        plot(x,y,'o','color',cmap(ii,:),'linewidth',2)  % show the cells
    end
end

if showDisplacementMap
    c = imagesc(inpaint_nans(dmap,5));
    uistack(c,'bottom');
    colormap(jet(255))
    caxis([0 dmax])
end
```