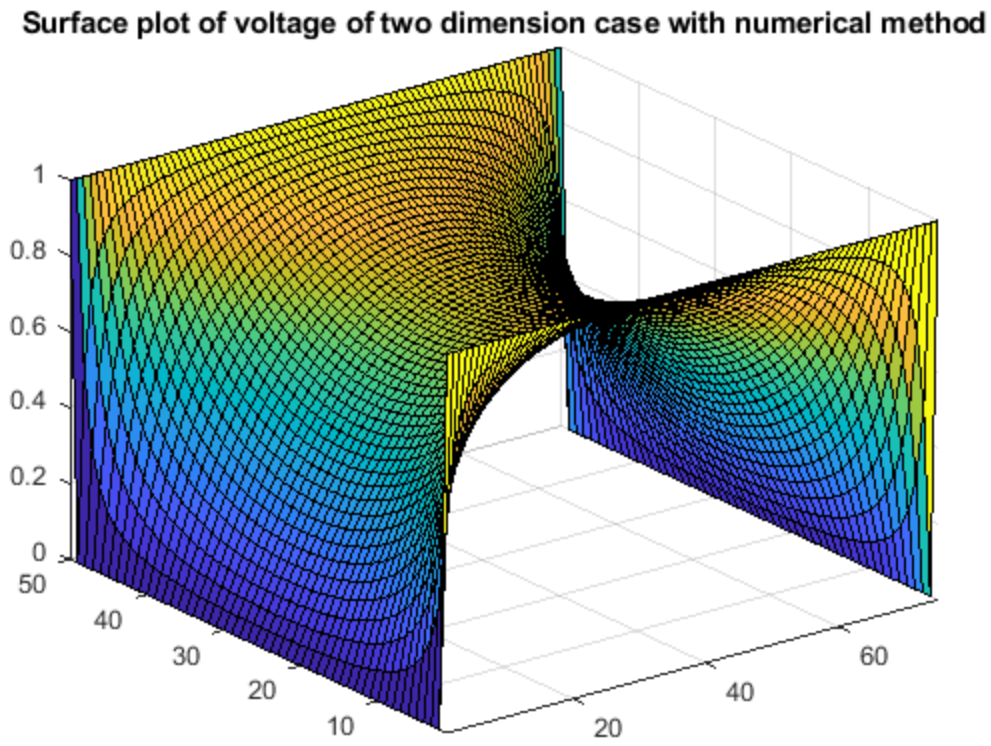
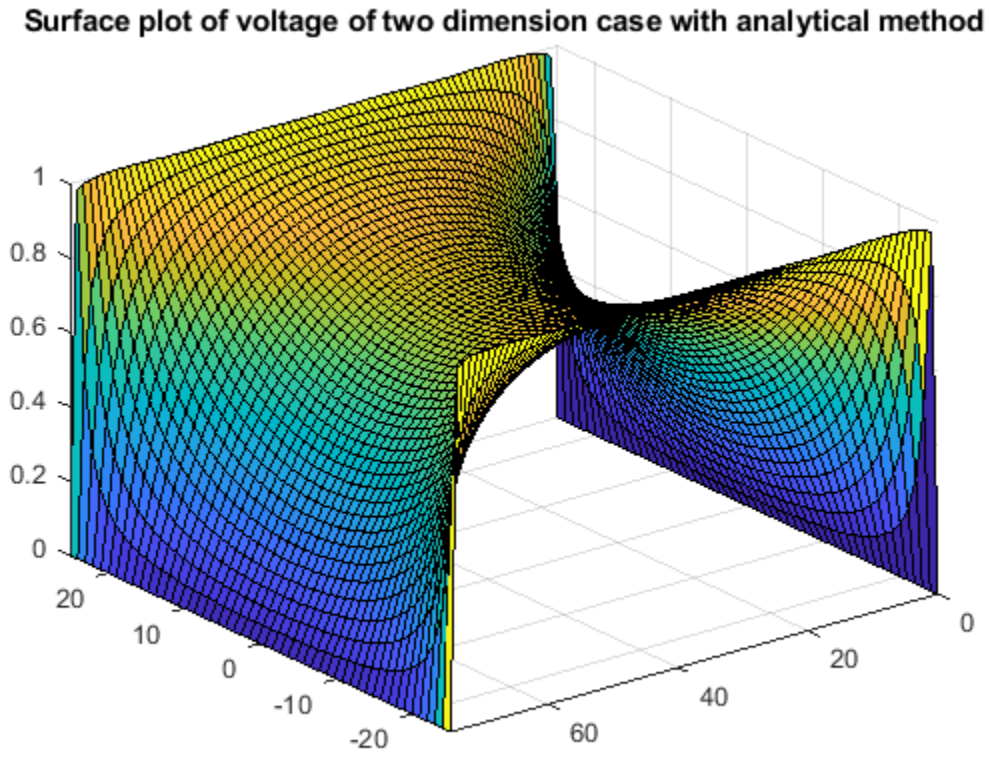
Part 1(b)

In part b, we are now trying to solve the case completely with finite difference method and analytical series solution, then comparing them to see the difference between two methods.

```
% Reset Everything
close all
clear

% Setting variables
nx = 50;                % Length of the region
ny = nx*3/2;            % Width of the region, 3/2 of length
G = sparse(nx*ny);      % Initialize a G matrix
D = zeros(nx*ny, 1);    % Initialize a matrix for G matrix operation

% Implement the G matrix for two dimension case
for i = 1:nx
    for j = 1:ny
        n = j + (i-1)*ny;

        if i == 1
            G(n, :) = 0;
            G(n, n) = 1;
            D(n) = 1;
        elseif i == nx
            G(n, :) = 0;
            G(n, n) = 1;
            D(n) = 1;
        elseif j == 1
            G(n, :) = 0;
            G(n, n) = 1;
        elseif j == ny
            G(n, :) = 0;
            G(n, n) = 1;
        else
            G(n, n) = -4;
            G(n, n+1) = 1;
            G(n, n-1) = 1;
            G(n, n+ny) = 1;
            G(n, n-ny) = 1;
        end
    end
end

V = G\D;    % Calculating the voltage with G matrix

X = zeros(nx, ny, 1);   % Initializing a matrix for inverting G matrix

% Inverting G matrix
for i = 1:nx
    for j = 1:ny
        n = j + (i-1)*ny;
```

```
        X(i,j) = V(n);
    end
end

% Surface plot of voltage of two dimension
figure(1)
surf(X)
axis tight
title("Surface plot of voltage of two dimension case with numerical
 method")

% Setting up variable for the series
series = zeros(ny,nx);
a = ny;
b = nx/2;
x = linspace(-nx/2, nx/2, 50);
y = linspace(0, ny, ny);
[xx, yy] = meshgrid(x,y);

% Solving the series by iterations
for n = 1: 2: 600
    series = (series + (cosh(n*pi*xx/a).*sin(n*pi*yy/a))./
(n*cosh(n*pi*b/a)));
    figure(2)
    surf(x, y, (4/pi)*series)
    axis tight
    view(-128, 31);
    pause(0.01)
end
title("Surface plot of voltage of two dimension case with analytical
 method")
```


Surface plot of voltage of two dimension case with numerical method
1
0.8
0.6
0.4
0.2
0
50
40
30
20
10
20
40
60


Surface plot of voltage of two dimension case with analytical method
1
0.8
0.6
0.4
0.2
0
20
10
0
-10
-20
60
40
20
0

Discussion

By using the series solution and solving it through iterations, it is possible to approach the solution that the finite difference method is able to create. However, the solution will start to break down if there are more than around 600 iterations for the series solution since the *cosh* and *sin* in the series solution will approach to infinity around that point of iterations.

To conclude, There is no limitation on solving complicated equations by using numerical method, except for hardware limitation if the equation is too complicated to compute; Using analytical method would be great for solving more simpler solution since it take less time relative to numerical method, however it might not able to compute the most accurate solution with the limitation of the equation itself since some equation could break down from certain components in the equation approaching to infinity.

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