
ENGR 451 - Lab 3

Convolution, Part II

```
test_lab3; % initialize test_lab3 function

% Problems #1-4
x = ones(1, 15);
h = ones(1, 3);
for lc = 5:5:15
    test_lab3(x, h, lc);
end
test_lab3(x, h, 50);

% Problems #5-7
for lx = 14:16
    x = ones(1, lx);
    test_lab3(x, h, 15);
end

% Problem #8-9
test_lab3(1, 1, 1);
test_lab3(1, 1, 10);

% Problem #10-12
% load lab2 % assumes you have 'seashell.wav' in your directory
x = seashell(:)';
test_lab3(x, fir_lp, 100);
test_lab3(x, fir_lp, 200);
test_lab3(x, fir_hp, 100);

Problem #1
    Your overlap-add function is correct
    Your overlap-save function is correct
Problem #2
    Your overlap-add function is correct
    Your overlap-save function is correct
Problem #3
    Your overlap-add function is correct
    Your overlap-save function is correct
Problem #4
    Your overlap-add function is correct
    Your overlap-save function is correct
Problem #5
    Your overlap-add function is correct
    Your overlap-save function is correct
Problem #6
    Your overlap-add function is correct
    Your overlap-save function is correct
Problem #7
    Your overlap-add function is correct
    Your overlap-save function is correct
Problem #8
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    Your overlap-add function is correct
    Your overlap-save function is correct
Problem #9
    Your overlap-add function is correct
    Your overlap-save function is correct
Problem #10
    Your overlap-add function is correct
    Your elapsed time is 880.88 usecs
    which is 12.6 times Matlab's elapsed time (69.7 usecs)
    Your overlap-save function is correct
    Your elapsed time is 958.82 usecs
    which is 13.8 times Matlab's elapsed time (69.7 usecs)
Problem #11
    Your overlap-add function is correct
    Your elapsed time is 505.82 usecs
    which is 6.71 times Matlab's elapsed time (75.4 usecs)
    Your overlap-save function is correct
    Your elapsed time is 565.32 usecs
    which is 7.5 times Matlab's elapsed time (75.4 usecs)
Problem #12
    Your overlap-add function is correct
    Your elapsed time is 863.58 usecs
    which is 10.5 times Matlab's elapsed time (82.38 usecs)
    Your overlap-save function is correct
    Your elapsed time is 1104.34 usecs
    which is 13.4 times Matlab's elapsed time (82.38 usecs)

```

Program Listings

```

disp(' ')
disp('--- overlap_add.m -----')
type('overlap_add')
disp('--- overlap_save.m -----')
type('overlap_save')

--- overlap_add.m -----

function y = overlap_add(x, h, lc)
    x_length = length(x);
    h_length = length(h);
    nChunks = ceil(x_length/lc);
    size_y = x_length + h_length - 1;
    y = zeros(1,size_y);
    for i=1:nChunks
        xindex = lc *(i-1) + 1;
        yindex = xindex;
        if(i == 1)
            if(nChunks == 1) %if the chunk is bigger than the convolution
                xchunk = zeros(1,lc);
                for j=xindex:x_length
                    xchunk(j) = x(j);
                end
            end
        end
    end

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        ychunk = conv(xchunk,h);
        for j=1:size_y
            yout(j) = ychunk(j);
        end
        y = yout;
    else
        xchunk = x(xindex:(xindex + lc - 1));
        ychunk = conv(xchunk,h);
        y(yindex:yindex+(length(ychunk)-1)) = y(yindex:yindex
+ (length(ychunk)-1)) + ychunk;
    end
    elseif(i < nChunks)
        xchunk = x(xindex:(xindex + lc - 1));
        ychunk = conv(xchunk,h);
        y(yindex:yindex+(length(ychunk)-1)) = y(yindex:yindex
+ (length(ychunk)-1)) + ychunk;
    else
        xleft = x_length - xindex + 1;
        xchunk = zeros(1,lc);
        for j=1:xleft %filling xchunk with the rest of x's numbers
            xchunk(j) = x(j+xindex-1);
        end
        ychunk = conv(xchunk,h);
        sizeout = size_y - yindex + 1;
        for j=1:sizeout %making sure that the size will be correct
            yout(j) = ychunk(j);
        end
        y(yindex:size_y) = y(yindex:size_y) + yout;
    end
end
end
end
--- overlap_save.m -----

```

```

function y = overlap_save(x, h, lc)
    x_length = length(x);
    h_length = length(h);
    nChunks = ceil(x_length/lc);
    size_y = x_length + h_length - 1;
    M = h_length - 1;
    xindex = 0;
    for i=1:nChunks
        if(i > 1)
            xindex = xindex + lc - M;
            yindex = xindex + M + 1;
        else
            xindex = 1;
            yindex = 1;
        end
        if(i == 1)
            if(nChunks == 1)%if the chunk is bigger than the convolution
                xchunk = zeros(1,lc);
                for j=xindex:x_length
                    xchunk(j) = x(j);
                end
            end
        end
    end
end

```

```

    ychunk = conv(xchunk,h);
    for j=1:size_y
        yout(j) = ychunk(j);
    end
    y = yout;
else
    xchunk = x(xindex:xindex + lc - 1);
    ychunk = conv(xchunk,h);
    y(yindex:length(ychunk) - M) = ychunk(1:length(ychunk) - M);
end
xindex = 0;
elseif(i < nChunks)
    xchunk = x(xindex + 1:xindex + lc);
    ychunk = conv(xchunk,h);
    y(yindex:yindex+length(ychunk) - 2*M - 1) = ychunk(M +
1:length(ychunk) - M);
else
    xchunk = x(xindex + 1:x_length);
    ychunk = conv(xchunk,h);
    y(yindex:size_y) = ychunk(M + 1:length(ychunk));
end
end
end
end

```

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