Brief Introduction on ReMapping Method

ver 1.0

This document briefly describes how the ReMapping method, an optimization for the range mapping method in Mitchell's logarithmic approximation method, is composed.

The introduction will be in file sequence: castrARM4.m, FindPoints.m, Fitting.m, FindCoefficients.m, AlgoReMapping_16bit.m, CastrARM16.m, FindPoints2.m. The underlined is the body of this method.

castrARM4.m

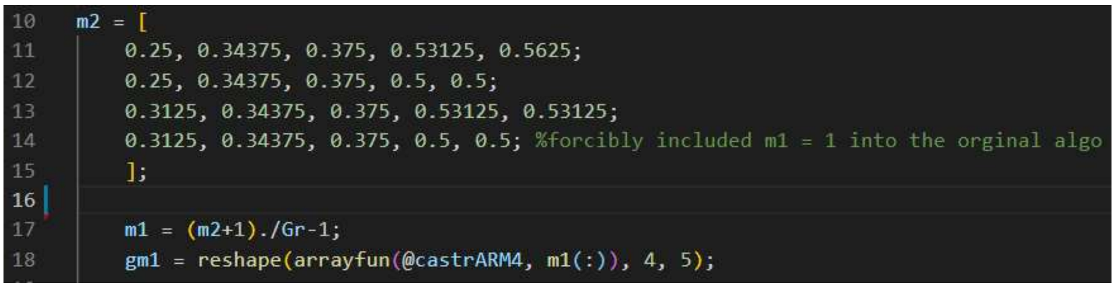
This function is a reduced version of the original function, AlgoRangeMapping4.m, with modifications of changing the inputs from a number to be calculated into only the mantissa *m1* to be approximated (that is, getting rid of the characteristic *k*, and forcibly including *m1*=1 into the range.

The goal of this function reduction is to ease the calculation of specific points corresponding to different *m1* values.

FindPoints.m

In the range mapping method, domain of the Mitchell curve is divided into 4 regions, most of which has 3 segments each except the 4-segment first region.

This script uses the castrARM4 function to calculate *m1*, *m2*, and the range mapped *gm1* for all critical points for reference purpose.



```
m2 = [
    0.25, 0.34375, 0.375, 0.53125, 0.5625;
    0.25, 0.34375, 0.375, 0.5, 0.5;
    0.3125, 0.34375, 0.375, 0.53125, 0.53125;
    0.3125, 0.34375, 0.375, 0.5, 0.5; %forcibly included m1 = 1 into the orginal algo
    ];

    m1 = (m2+1)./Gr-1;
    gm1 = reshape(arrayfun(@castrARM4, m1(:)), 4, 5);
```

Figure 1. part of the codes in FindPoints.m

The results are written into FindPoints.txt file.

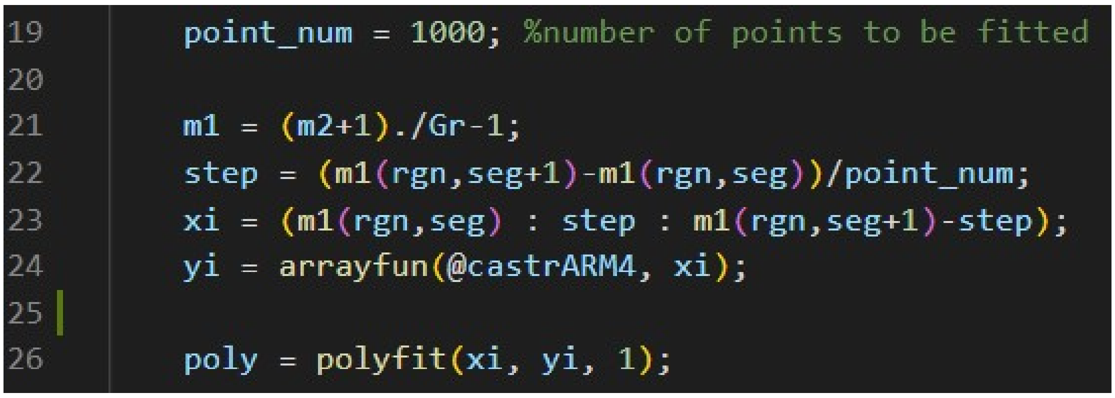
Fitting.m

From now on, we are getting into the ReMapping method. Fitting function can be invoked in such a form:

$$poly = Fitting(rgn, seg)$$

where *rgn* and *seg* are the number for region and segment respectively, and poly is the polynomial coefficients.

This function fits a reconfigurable number (e.g., 1000) of points in a certain segment and returns its polynomial coefficients.

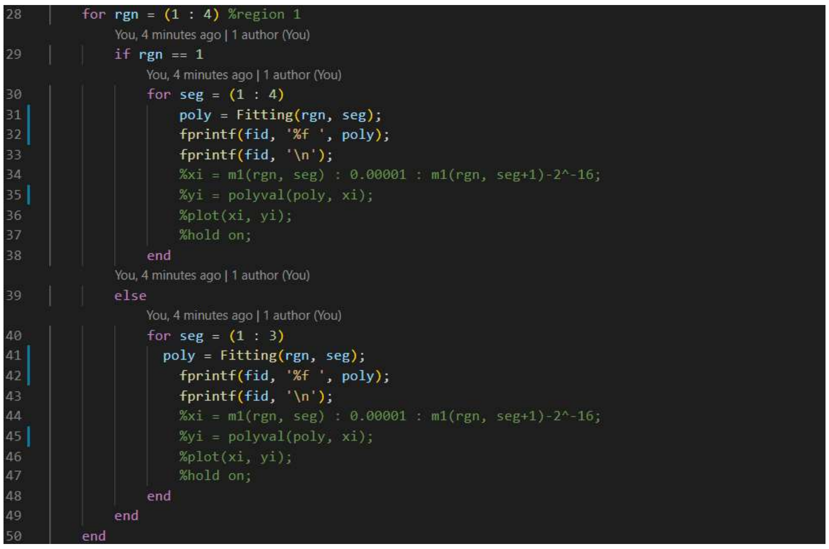


```matlab
    point_num = 1000; %number of points to be fitted

    m1 = (m2+1)./Gr-1;
    step = (m1(rgn,seg+1)-m1(rgn,seg))/point_num;
    xi = (m1(rgn,seg) : step : m1(rgn,seg+1)-step);
    yi = arrayfun(@castrARM4, xi);

    poly = polyfit(xi, yi, 1);
```

Figure 2. part of the codes in Fitting.m

FindCoefficients.m

This script uses two nesting loops of Fitting function to acquire all sets of coefficients for all segments and outputs them into FindCoefficients.txt file.



```matlab
    for rgn = (1 : 4) %region 1
        You, 4 minutes ago | 1 author (You)
        if rgn == 1
            You, 4 minutes ago | 1 author (You)
            for seg = (1 : 4)
                poly = Fitting(rgn, seg);
                fprintf(fid, '%f ', poly);
                fprintf(fid, '\n');
                %xi = m1(rgn, seg) : 0.00001 : m1(rgn, seg+1)-2^-16;
                %yi = polyval(poly, xi);
                %plot(xi, yi);
                %hold on;
            end
        You, 4 minutes ago | 1 author (You)
        else
            You, 4 minutes ago | 1 author (You)
            for seg = (1 : 3)
              poly = Fitting(rgn, seg);
                fprintf(fid, '%f ', poly);
                fprintf(fid, '\n');
                %xi = m1(rgn, seg) : 0.00001 : m1(rgn, seg+1)-2^-16;
                %yi = polyval(poly, xi);
                %plot(xi, yi);
                %hold on;
            end
        end
    end
```

Figure 3. part of the codes in FindCoefficients.m

Also, an overview plot of current method can be given by uncommenting.

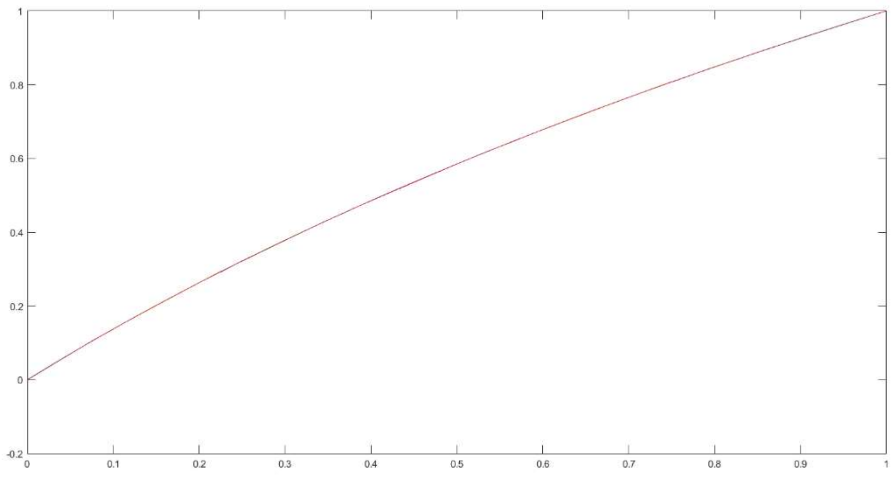
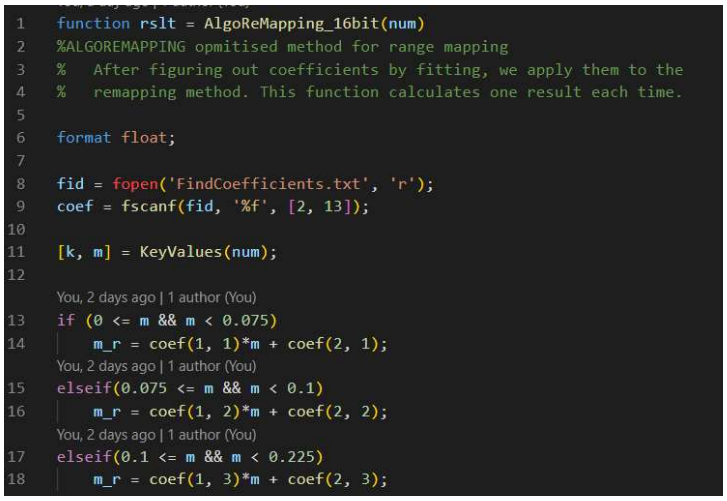


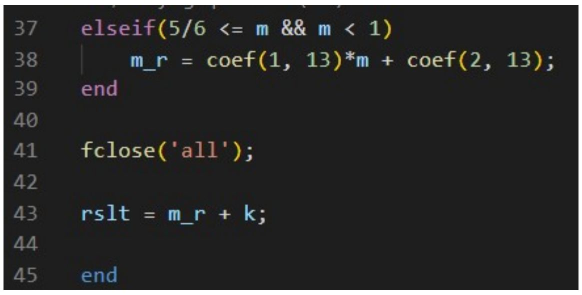
Figure 4. ReMapped curve and log($m1$+1) on the same plot

AlgoReMapping_16bit.m

With the coefficients acquired, it's rather simple a logic to complete the ReMapping method using a set of conditionals as following:



```
function rslt = AlgoReMapping_16bit(num)
%ALGOREMAPPING opmitised method for range mapping
%   After figuring out coefficients by fitting, we apply them to the
%   remapping method. This function calculates one result each time.

format float;

fid = fopen('FindCoefficients.txt', 'r');
coef = fscanf(fid, '%f', [2, 13]);

[k, m] = KeyValues(num);

You, 2 days ago | 1 author (You)
if (0 <= m && m < 0.075)
    m_r = coef(1, 1)*m + coef(2, 1);
You, 2 days ago | 1 author (You)
elseif(0.075 <= m && m < 0.1)
    m_r = coef(1, 2)*m + coef(2, 2);
You, 2 days ago | 1 author (You)
elseif(0.1 <= m && m < 0.225)
    m_r = coef(1, 3)*m + coef(2, 3);
```



```
elseif(5/6 <= m && m < 1)
    m_r = coef(1, 13)*m + coef(2, 13);
end

fclose('all');

rslt = m_r + k;

end
```

Figure 5. part of the codes in AlgoReMapping_16bit.m

CastrARM16.m and FindPoints2.m

Like what has been done in castrARM4.m and FindPoints.m, we can calculate some of the method results and compare them. (All rounded to six decimal places)

m1	ReMapping	difference with range mapping (*10^{-4})	difference with Log2(m+1) (*10^{-4})
0	-0. 000447	-4.470	-4.47
0.075	0.104941	-5.28	6.04
0.1	0.138184	0	6.80
0.225	0.291504	0	12.78
0.25	0.321332	-4.45	5.96
0.34375	0.427246	0	9.81
0.375	0.459961	0	5.29
0.5	0.584596	-3.65	-3.67
15/28	0.619629	0	7.19
4/7	0.652832	0	7.55
0.75	0.806764	-3.65	-5.91
19/24	0.842285	0	9.83
5/6	0.873535	-14.6	-9.35
1	1	0	0

Conclusion

Though further simulation is still to be done, this first version of ReMapping method can be believed as promising. The comparison of critical points results indicates close accuracy with the original range mapping method.

However, due to the non-linearity of segment 1 in each region, some of the results are unreliable especially those near the origin. This can be improved significantly by introducing several more segments with a length of LSB in each segment 1. The coefficients and number of these segments can be determined by simulation, which is exactly the next one on the to-do list.