

# Acceleration of FSK caller ID demodulation using SOS filter structure

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**Abstract** - In several systems such as VoIP analog gateway it is key feature to demodulate FSK caller ID signal on voice band. FSK caller ID are widely used as it has a lot of advantages[1] and to demodulate it correctly and speedily is important for stability of system operation as long as subscriber number increases.

In prior paper this subject has been researched, but sampling frequency is selected by special values that differ from typical values [2]. In other paper the system is constructed using the filter of floating coefficients (method 1) or using the filter of integer coefficients that is obtained by rounding the product of floating coefficients of long significant digit and special integer value and process additional operation to avoid over value state(method 2), so floating operations consume time[3].

The common communication systems use typical frequency such as 8 kHz and if FSK caller ID detection processing is running on embedded processors that support only fixed point operation then floating operation will consume hardly system resources.

This paper introduces the SOS structure of filter to realization of FSK caller ID demodulation, so not only ensures accuracy but also accelerates processing.

**Keywords** – FSK demodulation; caller ID; SOS filter

## 1. Introduce the FSK caller ID demodulation processing using filter

In this section introduce the FSK caller ID demodulation processing using filter and discuss the need to apply the SOS filter structure.

The block diagram of FSK caller ID demodulation process is shown in figure 1 [2].

As shown in figure 1, in first pass input signal the band pass filter that emphasize the 1(mark) signal and 0(space) signal, in next step get the subtraction of gotten signals' square, then pass subtraction result to low pass filter so that get last signal to detect 0 and 1 values and get caller ID information.

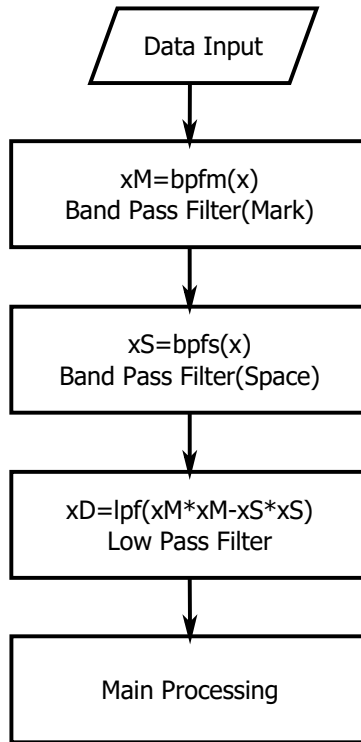


Figure 1. FSK caller ID demodulation using figure

Table 1 shows the analysis result of filter processing time consumption of method 1 and method 2 using code profiling tool, MicroProfiler. In this case we used FSK signal consists of 10 digit phone number and 15 character name data.

Table 1. Time consumption analysis of filter processing

	Iterate a time		Iterate 100 time	
	Whole calculation time	Time consumed in filter processing	Whole calculation time (average)	Time consumed in filter processing (average)
Method 1	3.12ms	1.36ms	2.73ms	1.19ms
Method 2	5.64ms	4.34ms	5.16ms	3.99ms

As shown in table 1, filter processing consumes large part in whole processing system resource (method 1: 43.5%, method 2: 76.9%).

Meanwhile SOS filter structure is known that it decreases the significant digit number of coefficients.

From the fact making filter calculation to integer operation of short significant digit number decrease the filtering operation load and accelerate the whole calculation, we propose introducing SOS filter structure to FSK caller ID demodulation.

## 2. FSK caller ID demodulation using SOS filter and result analysis

### 1) Construction of SOS filter

In first we have constructed the SOS filter coefficients of all filters.

In base of floating coefficients of prior paper [2] we constructed three order SOS filter structures and quantize the filter with some criteria using Matlab filter design tool. In this time make SOS filter's gain to be inverse value of 2's exponentiation and gaining is processed by divide or right shift operation.

In figure 2 show the magnitude response of original filter and corresponding SOS filter.

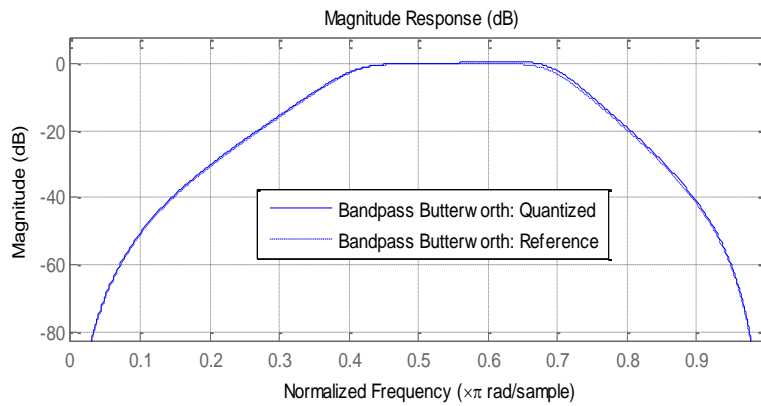


Figure 2. Magnitude response of original filter and corresponding SOS filter

### 2) Realization of SOS filter

Now we use pre-defined method for programming realization of SOS filter [4]. The processing for each time step is as following.

$$\begin{aligned} xi &= \text{Input Signal} \\ t &= G(0) \times xi - a01 \times IC00 - a02 \times IC01 \\ xi &= b00 \times t + b01 \times IC00 + b02 \times IC01 \\ IC01 &= IC00; IC00 = t \end{aligned}$$

$$\begin{aligned} t &= G(1) \times xi - a11 \times IC10 - a12 \times IC11 \\ xi &= b10 \times t + b11 \times IC10 + b12 \times IC11 \\ IC11 &= IC10; IC10 = t \end{aligned}$$

$$\begin{aligned} t &= G(2) \times xi - a21 \times IC20 - a22 \times IC21 \\ xi &= b20 \times t + b21 \times IC20 + b22 \times IC21 \\ IC21 &= IC20; IC20 = t \end{aligned}$$

$$yi = xi(\text{filtering result})$$

### 3) Analysis of calculation speed

Using two prior method and proposed method, we have analyzed demodulation speed for the FSK caller ID consist of 10 digit number and 15 character name. After pre-reading identical voice FSK data, then analyze pure time consumption of FSK demodulation.

Figure 4 shows the last filtering result for original filtering by floating operation and SOS filtering, and we can confirm that SOS filters keep accuracy.

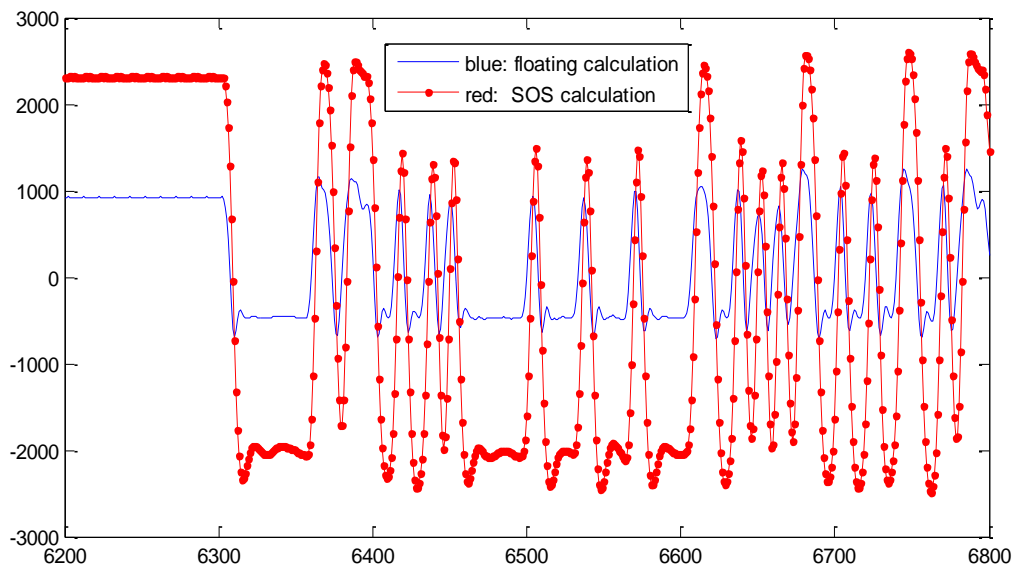


Figure 3. Comparison of last filtering result

Table 2 shows the result of profiling with Microprofiler.

Table 2. Comparison of calculation speed

	Iterate a time		Iterate 100 time	
	Whole calculation time	Time consumed in filter processing	Whole calculation time (average)	Time consumed in filter processing (average)
Method 1	3.12ms	1.36ms	2.73ms	1.19ms
Method 2	5.64ms	4.34ms	5.16ms	3.99ms
Proposed	1.45ms	0.44ms	1.19ms	0.35ms

As shown in table 2, the method we proposed is faster than methods process floating point operation.

### 3. Conclusion

We have introduced SOS filter structure for FSK caller ID demodulation processing. So that accuracy is kept and calculation speed becomes faster, the load of system such as VoIP analog gateway that process FSK caller ID demodulation is decreased.

### References

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