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Earth Science and Engineering

Super Virtual Interferometry

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Abstract: Super virtual interferometry (SVI) can be used to enhance the refracted arrival of data sets contaminated by other noises. By combining the slide window, the enhancement can be improved further. In theory, first of all, SVI adopts cross-correlation to capture the time difference between two different traces which of time difference is constant in some simplicities. For different sources, stacking these time difference from different source forms a virtual source. Last, convolution is used to obtain the time from true source to truce.

To enhance the S/N, Karhunen-Loeve filtering, amplitude correction, FX-deconvolution, 2D Weiner filter, FX filter and 1D median filter are used. Results of filed data show processing enhances the coherency of the data and enhance S/N. For example, Karhunen-Loeve filtering can enhance coherency in common offset gather while FX-deconvolution can be used to remove the random noise which bursts along the whole frequency spectrum and bandpass filter fails to remove it. In addition, 2D adaptive wiener filter is used to smooth the frequency spectrum and amplitude anomalies and FK filter can be used to remove linear noise. The future study includes running SVI for far offset and performing reflection processing to estimate the normal move-out (NMO) velocity.

1 Introduction

To detect Qadema fault and subsurface geology, the field is designed. The parameters are following. The number of shots and receivers for every single shot are 240. The interval of shots and receiver are 5m and the total length of survey line is 1200m. To save the space, the description to field survey is not presented here.

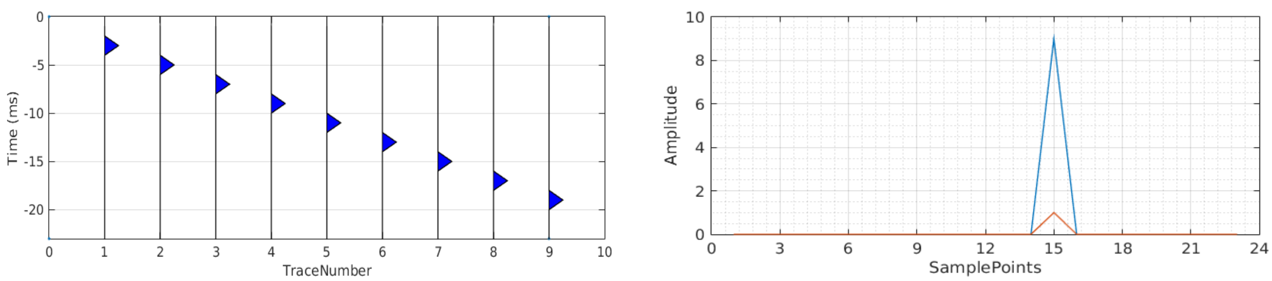
2 Theoretical Aspect of SVI

The detailed theory and practice implementation can be find in some publications (Shuqian Dong et al., 2006).

3 Numerical Results

In this project, at first, we implemented the SVI for sythentic data and other processing flows are used to enhance the S/N.

3.1 Synthetic data

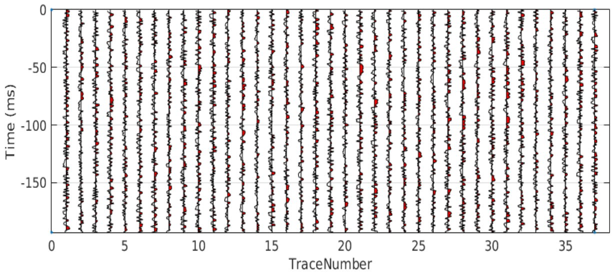


(a) Synthetic data by adding noise

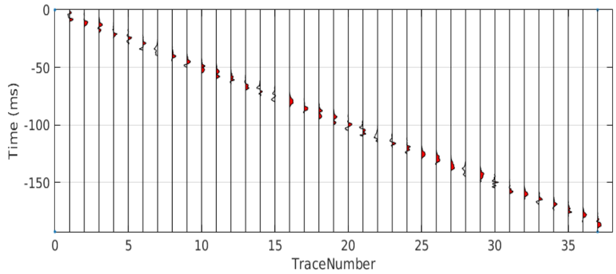
(b) The first trace and its enhanced trace

Figure 1: noise-free data and enhanced data by SVI

In figure 1, first, two receiver gathers are synthesized, and every gather contains 9 traces. Then cross-correlation is used to capture the time difference between traces from different shots. By some simplicities, which time difference can be considered as constant, thus adding them together can enhance the S/N.



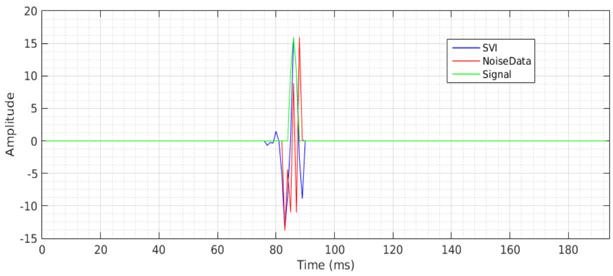
(a) Sythetic data in one of common receive gathers



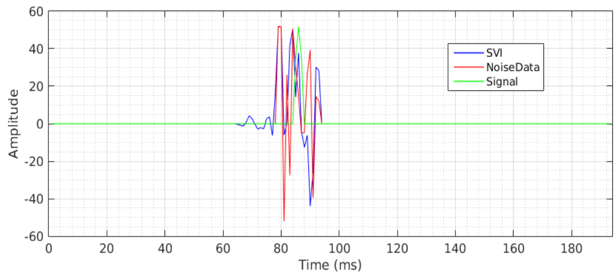
(b) Recovered data using SVI

Figure 2: The second test to SVI with noise data

In this test, first, we add Gaussian noise to data. From figure2(a), the refraction arrival cannot be recognized. To capture them, SVI is used with the combination of slide window. However, the length of window is very small and contains the true signal. For example, the signal contains 3 spikes while window is extended along both sides of signal to 7 points. If the window becomes large, the length of window is 7 points in the second test while it is 15 points in the third test, which of result shows that some ambiguity is introduced. In the third test, to enhance the S/N further, we used 37 traces.



(a) The result of SVI using lucky window

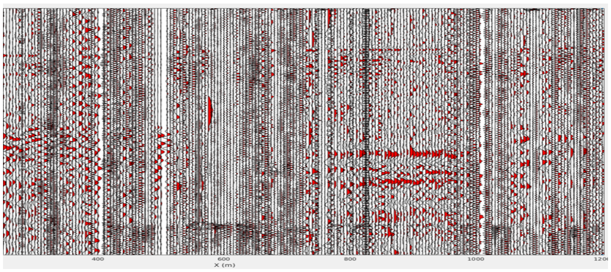


(b) The result of SVI using less-lucky window

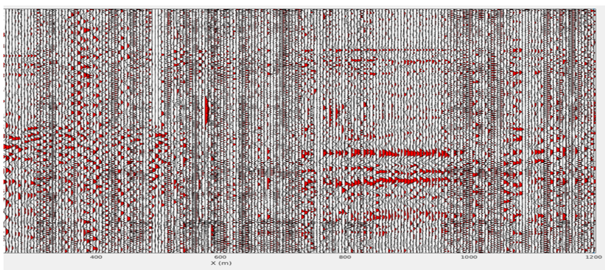
Figure 3: The 17th trace compassion between true trace (green), noise trace (red) and recovered trace(blue)

3.2 Field data

In this part, Karhumen-Loeve filtering, amplitude correction, FX-deconvolution, 2D Weiner filter, FK filter and 1D median filter are used to enhance the target signal. For Karhunen-Loeve filtering, the data set is sorted into common offset domain. For left hand side, the operator length is 20 while which is 40 for right hand side (M.D Sachi, SAIG, 2008). Because our report be restricted to 2-3 pages, so some results do not contain in this paper.

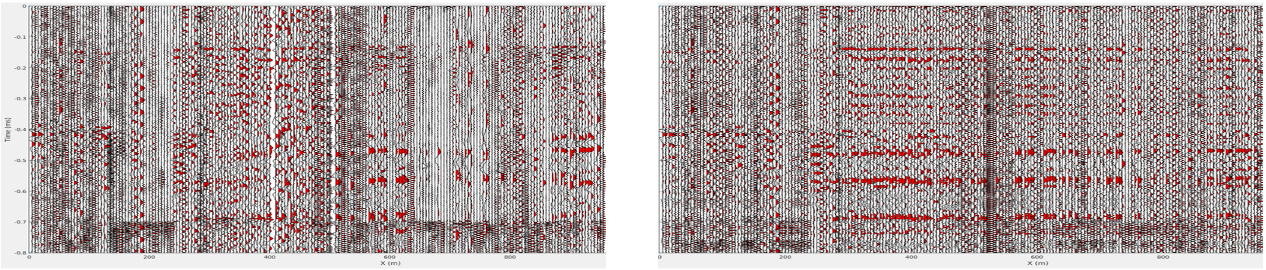


(a) Raw data with less coherency



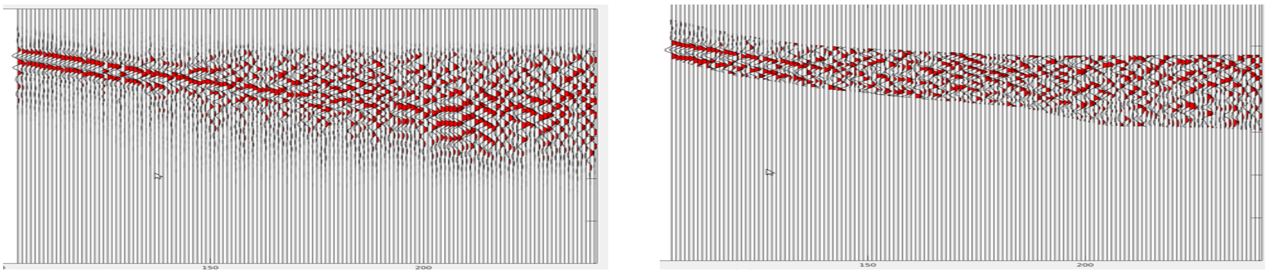
(b) Data of filtering by Karhumen-Loeve method

Figure 4: Coherency enhancement by Karhumen-Loeve method



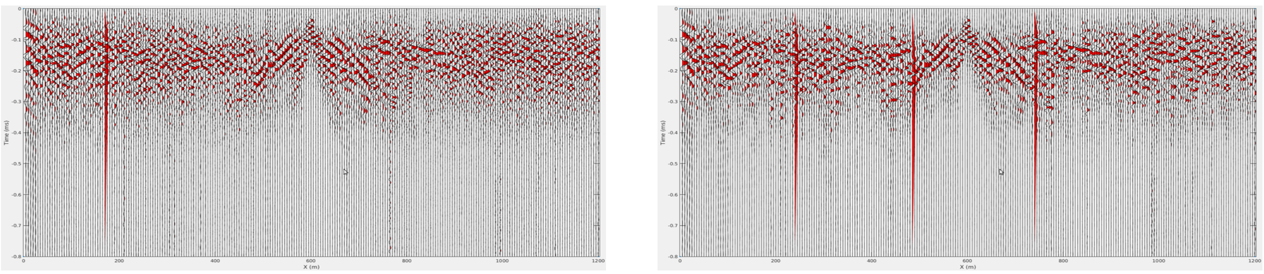
(a) Sythetic data in one of common receive gathers (b) Recovered data using SVI

Figure 5: The second test to SVI with noise data



(a) Recoved signal by SVI (b) A part of raw data as a input to SVI

Figure 6: segmented data by slide window (b) and SVI result (a)



(a) The result of 2D Weiner filter (b) Raw data with some random noisy

Figure 7: Raw data (b) and the result of applying 2D Weiner filter

4 Conclusion

In this project, first, the theoretical aspect and practical implementation are checked. Results show that SVI can be used to enhance the refraction arrival in some simplicities. In the second part, Karhumen-Loeve filtering, amplitude correction, FX-deconvolution, 2D Weiner filter, FK filter and 1D median filter are used to enhance the target signal. For Karhunen-Loeve filtering, the data set is sorted into common offset domain. The results show that above methods can enhance the target signal and remove some special types of noise.

5 Acknowledgement

First of all, we thank Professor Gerard Schuster for his knowledge, patience, enthusiasm and kind. In addition, special thanks to WWW, which makes learning become more convenient, more effective and more equitable.