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Picking up the First Arrivals in VSP Based on Edge Detection

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Abstract. The information of the first arrivals in vsp data plays a very important role in the wave field separation. Picking up the first arrivals of zero-offset vsp, we can acquire the relationship between velocity and time about the underground medium of the well. And it can provide effective technical support and data assurance in the succeeding vsp data processing. This paper implements to pick up the first arrivals in the actual seismic data by some traditional edge detection operators: such as Roberts, Sobel, Prewitt, Laplace, Canny in digital image processing and Matlab functions relevant with operators after establishing the forward model. The experimental results show that canny operator and Laplace operator always have a pseudo-edge effect, the effects of edge detection are not as good as Roberts, Sobel, and Prewitt operator.

Keywords: image processing, edge detection, first arrival, picking the first arrivals, forward model.

1. Introduction on Edge Detection

Image is the important source of information for mankind understanding the world .In an image, edge is in irregular structure and unstable phenomenon. That is edge is the locality which is suddenly changing, so it often carries the great number of information in image [1]. Edge detection is the most fundamental issue in the field of image processing. With resolving it, it is significant affect for us conducting high-level feature extraction, feature description, target recognition, and image comprehension and so on. So edge detection occupies important areas in digital image processing. This paper achieves picking up the first arrival in the data of vsp by edge detection so as to provide demand information about wave field separation, acquire information of underground medium beside well about the relationship of velocity and time.

The technology of edge detection is extremely important in processing digital image. Because edge is a boundary line between target and background, it can be separated by edge detection. In an image, boundary indicates the end of one feature region and the beginning of another. Inner feature or attributes of the same region divided by boundary are consistent, and yet in the different region, they are different. Edge detection realizes just by taking advantage of the background diversity of image nature, including grayscale, color or texture feature. In fact edge detection is detecting the points which are taking change in image nature.

The simplest method of edge detection is edge detection algorithm. It utilizes the discontinuous nature of the pixel values in adjacent region, using first or second derivative to detect edge points. Edge detection algorithms detect the change in grayscale of image by finding extreme points of first derivative or zero crossing of second derivative. First derivative algorithms frequently used are gradient operator, prewitt operator, sobel operator, and second derivative Laplace [2] [3] operator, canny [4] operator.

First arrival is the junction points between useless information such as random interference signals and actual seismic signals. It has good continuity in seismic records and apparent interface with other signals. If taking seismic traces or gather as an image, the classic edge detection algorithm in image processing can extract boundary. That is first arrival can be extracted in seismic records. It is the apparent boundary feature

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of first arrival that establishes the bridge with image processing. In good first arrival situation, the boundary points by edge detection are the actual first arrival.

2. Process of Achieving to Pick up First Arrival by Edge Detection

This paper takes three layers horizontal of uniform media as a model, establishes forward model of vsp, and level the first arrival by calculating the arrival time [5]. After transforming actual seismic data read to image, achieve to pick up the first arrival by edge detection.

2.1. Establishment and synthesis of forward model using seismic data

Assume the sampling frequency of detector is 1, sampling points are 3000, and every shot has 300 trace records. The apparent velocities in three layer media are 1800,3000,5600.The depth of the first layer media is 800,second 2000 and third 3200.The first detector's depth is 120.The interval between detectors is 10.Where the above-mentioned numbers take international system of units.

The following figures are the forward model of three layers horizontal media taking ricker wavelet as source signal and the leveled model.

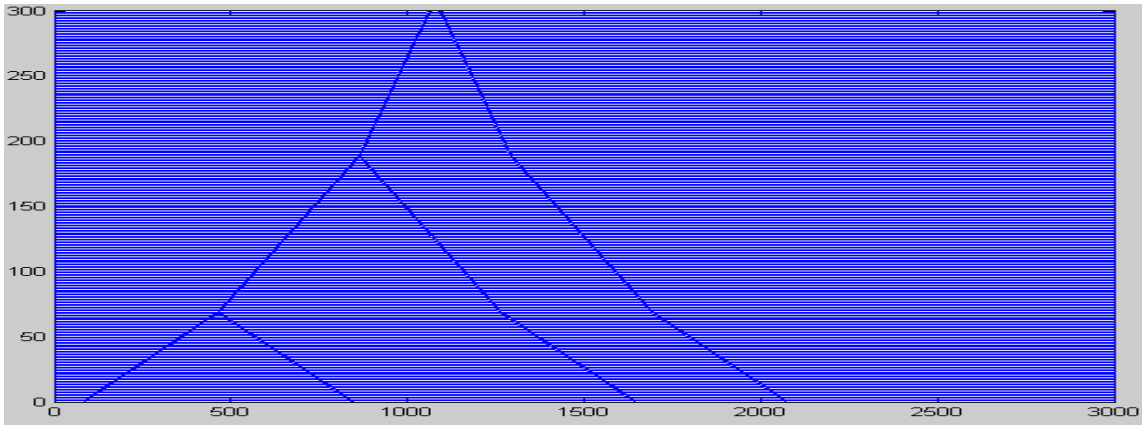

Fig. 1: forward model

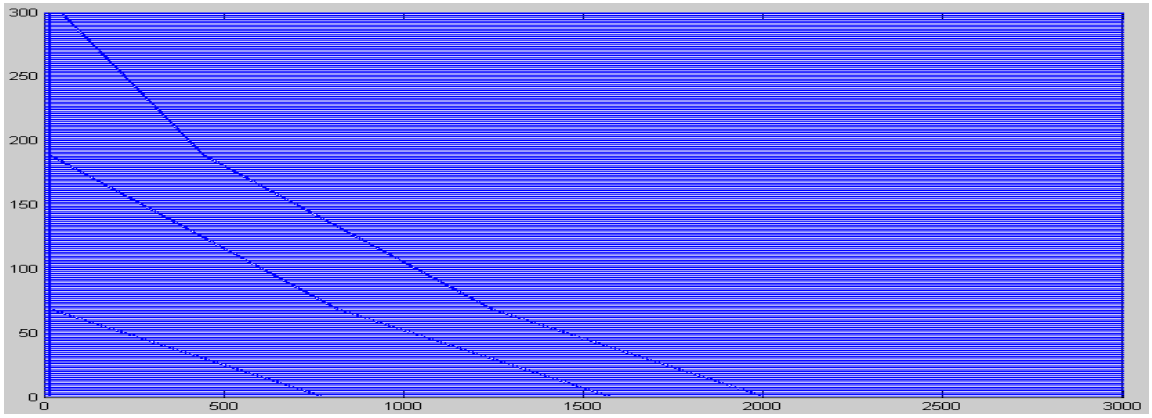

Fig. 2: levered model

2.2. Reading the SGY format and transforming between image and seismic data

The SEGY format of seismic data constitutes of shots of seismic records arranged in the manner of road sequence. The record of every shot composes of header and seismic data volume. There are trace header and sampled values in seismic data volume. The standard of SEGY format includes 3200 bytes SEGY header, 400 bytes binary ASCII header, and 240 bytes SEGY trace header. 3200 bytes and 400 bytes are named the header of seismic data, and 3600 bytes in all. The actual seismic data are stored from the beginning of 241 bytes one by one [6]. It is shown below.

Optional SEGY Tape Label	3200 Byte Textual File Header	400 byte Binary File Header	1st 3200 byte Extended Textual File Header (Optional)		N st 3200 byte Extended Textual File Header (Optional)	1st 240 byte Trace Header	1st Data Trace		M st 240 byte Trace Header	M st Data Trace

Fig. 3: the SEGY format

Read the sampling points, the sampling rate, the total bytes of SEGY and seismic data using functions in matlab, such as fseek, ftell and so on. Calculate the trace number, draw grayscale image which is necessary in edge detection using function of mat2gray.Where the parameter of function is seismic data.

```
fid = fopen('f:\mywork\sgyread\xc12_p0_z_raw.sgy','r');
if ~fid
    {
        disp('can"t open file!');
        exit;
        }
end
fseek(fid,3220,'bof');
sample = fread(fid,1,'int16','b');
fseek(fid,3216,'bof');
T = fread(fid,1,'int16','b');
fseek(fid, 0, 'eof');
file_n = ftell(fid);
Tn = (file_n-3600)/(sample*4+240) ;
fclose(fid);
seismic_data = zeros(Tn,sample);
for j = 1:Tn
    fseek(fid,3600+j*240+(j-1)*sample*4,'bof');
    seismic = fread(fid,[1,sample],'float32','b');
    seismic_data(j,:) = seismic;
end
fclose(fid);
```

2.3. Process of achieving edge detection

We conduct to detect edge of grayscale image by using the edge function in Matlab, where the second parameter is selected in log, prewitt, canny, sobel and Roberts.

Laplace operator uses the principle of edge points appearing zero-crossing in second derivative to detect edge. It has no direction, is sensitive to grayscale mutation and has good positioning accuracy. However it has poor ability of anti-noise. Because of the noise affect, it can detect some discontinuous edges. It often applies to detect roof type edge.

Prewitt operator is the same as sobel. However it has low positioning accuracy and detects multi-pixel width easily. This operator in positioning edge is not as good as roberts operator.

Canny operator is first derivative of Gaussian function, and is optimal approximation operator for product between signal to noise ratio and positioning.

The steps of sobel operator are as follows. The first step is weighted smoothing image. And the second is proceeding to conduct differential operation. It has some certain ability of noise suppression and good edge positioning effect. But it cannot remove false edge and detect pseudo-edge. It is suitable for the occasion of low accuracy requirements.

Roberts operator uses the difference approximate gradient amplitude between two adjacent pixels in diagonal direction to detect edge. The effect in detecting horizontal and vertical edge is better than oblique edge. It has high positioning accuracy, but loses some edges easily. At the same time because image is smoothed, it is more sensitive to noise. This operator has good effect for steep edge and low noise image.

```
original = mat2gray(seismic_data');
imtool(original,'InitialMagnification', 100);
BW_log = edge(I,'log');
imtool(BW_log,'InitialMagnification', 100);
BW_prewitt = edge(I,'prewitt');
imtool(BW_prewitt,'InitialMagnification', 100);
BW_canny = edge(I,'canny');
imtool(BW_canny,'InitialMagnification', 100);
BW_sobel = edge(I,'sobel');
imtool(BW_sobel,'InitialMagnification', 100);
BW_roberts = edge(I,'roberts');
imtool(BW_roberts,'InitialMagnification', 100);
```

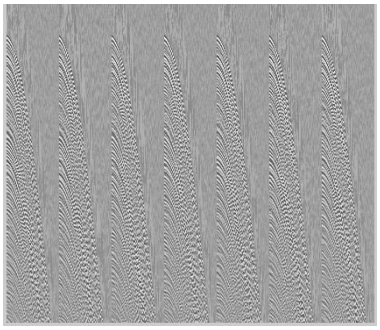

Fig. 4: original

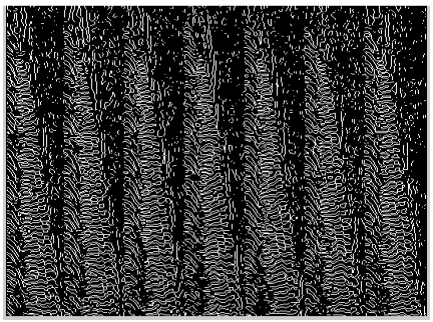

Fig. 5: BW_log

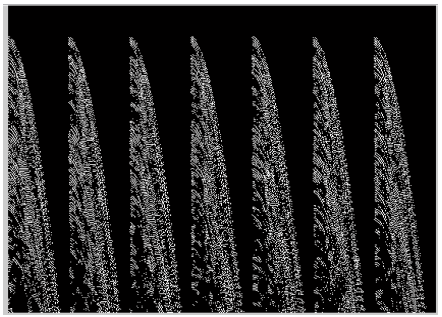

Fig. 6: BW_prewitt

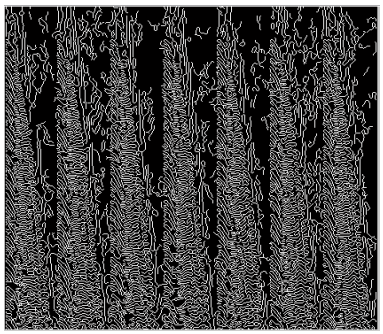

Fig. 7: BW_canny

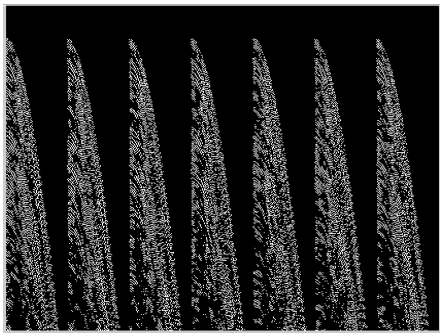

Fig. 8:BW_sobel

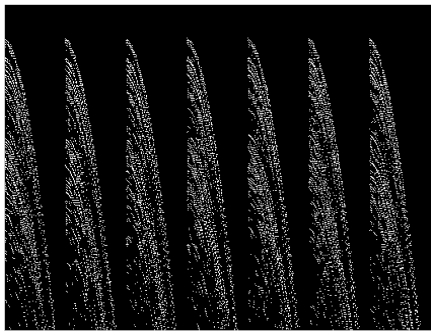

Fig. 9:BW_roberts

3. Conclusions

This experiment synthesized vsp forward data that are need by study of ray theory and model establishment and transform file formats between image and SEGY and information between edges in image processing and first arrival by analyzing their relationship.

On Matlab, we achieved all kinds of edge detection operators mentioned above, preliminary deal with vsp data, laid solid basis for the following processing such as wavelet shaping, wave field separation, deconvolution, and corridor stack and so on.

4. Acknowledgements

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5. References

[1] Zeng Huan, Wang Hao. Comparison and Analysis for Performance of Image Edge Detection Algorithms. Modern Electronic Technology, 2006, (14):53-58.

[2] Rafael C. gonzalez, Richard E. Wood. Digital Image Processing (Second Edition) [M].Prentice Hall, 2002, 45-621.

[3] Yu Songhuang, Zhou Yuanhua, Zhang Rui. Digital Image Processing. Shanghai Jiao Tong University Press.2007:272-312.

[4] Canny J. A Computational Approach to Edge Detection [J]. IEEE Pattern Analysis and Machine Intelligence 1986,8(6)：679-698.

[5] Yu Zhihua, Hu Cunming. The Calculation Method about Standard values of the Arrival Time [J]. Oil Geophysical Prospecting. 1997，32:188-192.

[6] Michael W. Norris, Alan K. Faichney. SEG Y rev 1 Data Exchange format [J].Society of Exploration Geophysicist. 2001.