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OPTIMIZING RESOURCES

Deriving High Quality Horizontal Positioning of Seismic Receivers Directly from GPS Receivers Embedded in Wireless Seismic Receiver Nodes

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Our work demonstrates that positional data derived from the GPS receivers embedded in wireless seismic receiver nodes can achieve horizontal positioning quality which complies with the minimum standard required for seismic data acquisition operations. While the original purpose of the GPS receivers within seismic receiver nodes was to derive accurate timing data so that seismic data could be extracted from receivers to coincide with the timing of T0 for the seismic source, we demonstrate that it is also possible to derive the required level of horizontal position quality from these data.

Introduction

The advent of wireless nodal receiver technology opens up a host of new possibilities for seismic survey design and acquisition. These include potential step-change improvements in quality as well as opportunities for enhanced efficiency and a corresponding reduction in field costs. Our vision is that these reductions in field costs should be used to acquire denser spatial sampling and further improve data quality with a particular focus on reservoir characterization in unconventional reservoirs.

As we seek to improve both the quality of the data and the efficiency of the operation, we have identified a new efficiency that also enhances data quality. This comes in the form of positions that are self-derived from the nodes themselves. It turns out that when properly configured, most wireless nodes on the market today are already capable of acquiring position data. Our work demonstrates that when this data is properly acquired and processed, the resulting positions derived are more representative of geophone placement in the field than using existing survey positioning techniques. In addition to eliminating the cost of surveying receiver points, this also facilitates the use of fully stakeless receiver deployment.

Theory and/or Method

GPS receivers embedded in nodes were an ingenious way for the engineers and manufacturers of those wireless systems to solve the problem of timing. Because GPS is a time based positioning system, wireless nodal acquisition systems use this GPS timing data to correlate the receiver data with the timing of the seismic source.

While these systems use positioning data as a QC tool, acquisition contractors continue to rely on survey crews to survey receiver positions as the GPS positioning data collected by the node is not corrected via either Real Time Differential (RTD) or Real Time Kinematic (RTK) corrections and is therefore not seen to be sufficiently accurate for establishing receiver positions.

While this assumption is true of any single position calculated by the nodes, we theorized that because the nodes are collecting positioning data continuously typically 24 hours a day for many consecutive days on end, a high quality position could in fact be derived by using all of the positioning data acquired by the node for any given receiver location. We also theorized that the final calculated positions could be made

increasingly accurate by processing the numerous records based on certain positional quality indicators. In some wireless nodes, these data are contained within ‘engineering files’ that are not normally downloaded from the node. In other nodes, these data are more readily available.

We acquired a large quantity of wireless nodal data from several systems beginning in Q4 2011 in the field, at static locations in Calgary and over multiple seasons from 2011 to present. To confirm our work, we ensured that many of the receiver positions were identical to positions occupied in previous seasons (we actually used the same hole in the ground to position the 3-component receiver).

We then processed the data using an algorithm devised to make the best use of the available data from each node.

It was immediately obvious that the positions were very robust. We then sent surveyors to the field equipped with RTK GPS systems which carry a theroretical antenna accuracy of 10 millimeters to survey the actual locations of the receivers. This work confirmed the positional reliability of the node-derived positions and also that the nodal positioning was superior in determining the final geophone position compared to the commonly used method of surveying receiver positions with RTK GPS ahead of receiver deployment.

Examples

Image examples, statistics and diagrams will be included in the final paper and presentation.

Conclusions

The currently employed practice of surveying receiver positions ahead of layout is rendered obsolete with the advent of wireless seismic receiver nodes with embedded GPS receivers. The quality of the horizontal positioning data for seismic receivers is improved with this method. By combining these horizontal positions with high resolution LiDAR data for vertical positioning, the quality of the receiver positioning solution is improved. While the importance of this qualitative improvement in receiver position relative to the resulting seismic image will be a function of seismic acquisition parameters and the required seismic resolution to image the target objective, the efficiency gain and cost savings that flow from modifying field operations to incorporate this method offer that optimal result of improved quality and lower cost.

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References

Will be provided with paper and presentation.