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GENERALIZATION OF THE METHOD FOR SINGLE-HYDROPHONE GEOACOUSTIC INVERSION: APPLICATION TO A WAVEGUIDE WITH INHOMOGENEOUS BOTTOM RELIEF

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Recently, works on reconstructing waveguide parameters (sound speed, density, etc.) from data recorded by a single hydrophone has been of increasing interest. Traditional methods of geoacoustic inversion are well known and discussed in sufficient detail in many works. They are quite accurate, but they require acoustic data recorded by arrays of hydrophones (antennas). Recently, a geoacoustic inversion method has been presented for relatively shallow water waveguides. It allows to determine not only the parameters of the waveguide, but also the distance to the source, using acoustic data recorded by a single hydrophone. This method is based on the use of the so-called warping transform or deformation operator, which allows to straighten the dispersion curves and greatly improve mode separability. The dispersive curves separated from each other allow us to extract the information about the modal delay times (or modal group velocities) which may be used for the inversion of media parameters. This paper presents an algorithm for geoacoustic inversion, both for model and real waveguides. In this work, the geoacoustic inversion method using the recording of a pulsed acoustic signal by a single hydrophone was generalized to the case of an irregular waveguide. This generalization makes it possible to take into account smooth bathymetry inhomogeneities on the considered acoustic path.

Keywords: ocean acoustics; geoacoustic inversion; waveguide dispersion; warping transform; acoustic modes.

References

1. Bonnel J., Chapman N.R. Geoacoustic inversion in a dispersive waveguide using warping operators // J. Acoust. Soc. Am. 2011. Vol. 130. P. EL101–EL107.

2. Zeng J., Bonnel J., Chapman N.R. Inversion of seabed attenuation using time-warping of close range data // J. Acoust. Soc. Am. 2013. Vol. 134. P. EL394–EL399.

3. Le Touze G., Nicolas B., Mars J.I., Lacoume J-L. Matched representations and filters for guided waves // IEEE Trans. Signal Process. 2007. Vol. 57. P. 1783–1795.

4. Katsnelson B., Petnikov V., Lynch J. // Fundamentals of shallow water acoustics. 2012, Springer, New-York et al.

5. Jensen F.B., Porter M.B., Kuperman W.A., Schmidt H. Computational ocean acoustics // Springer, 2011, New-York et al.

6. Tolstoy I., Clay C. Ocean Acoustics: Theory and Experiment in Underwater Sound // Acoustical Society of America, New York, 1987.

7. Baraniuk R.G., Jones D.L. Unitary Equivalence: a new twist on signal processing // IEEE Trans. Signal Process. 1995. Vol. 43. P. 2269–2282.

8. Le Touze G. Localisation de source par petits fonds en UBF (1–100 Hz) à l'aide d'outils temps-fréquence // Thèse doctorale, 2007.

9. https://github.com/kaustikos/ac_modes (дата обращения: 10.02.2021).

10. Rutenko A.N., Kozitsky S.B., Manul'chev D.S. Effect of a sloping bottom on sound propagation // Acoustical Physics. 2015. Vol. 61, No. 1. P. 76.

11. Sergeev S.N., Shurup A.S., Godin O.A., Vedenev A.I., Goncharov V.V., Mukhanov P.Yu., Zabotin N.A., Brown M.G. Separation of acoustic modes in the Florida straits using noise interferometry // Acoustical Physics. 2017. Vol. 63, No. 1. P. 73–83.

12. Gratchev G.A., Kuznetsov G.N. On average phase variation velocity of acoustic field in a plane waveguide // *Akusticheskij Zhurnal*. 1985. Vol. 31. No. 2. P. 266–268.

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