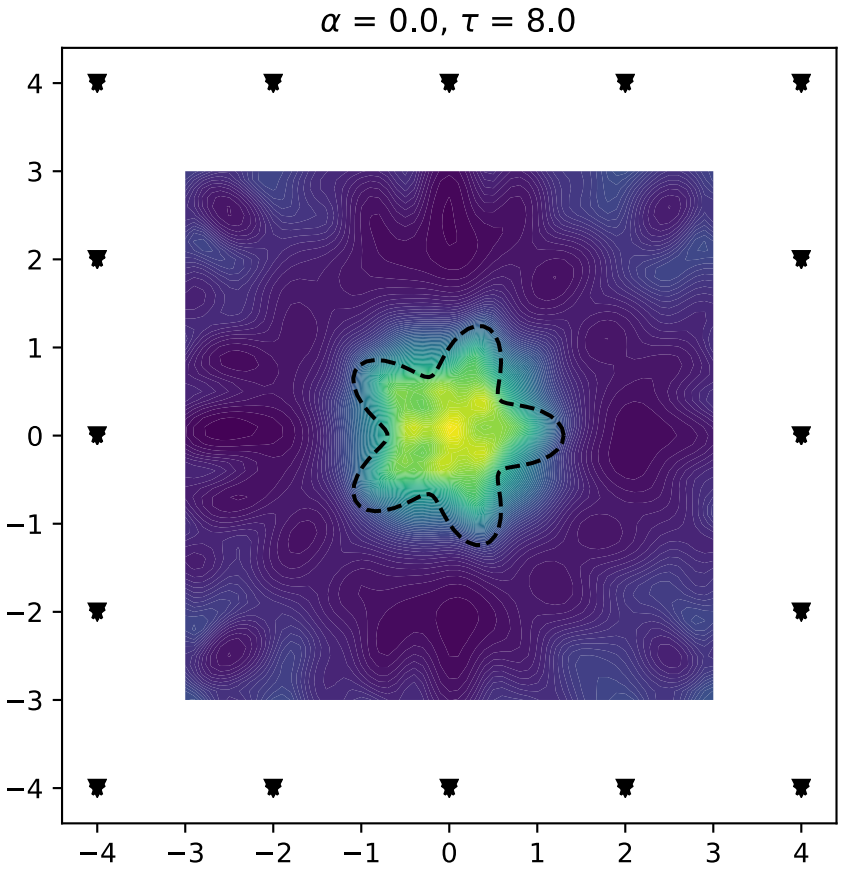
Vezda

User Manual

Usage, Algorithms, and Theory



Version 0.0.3

Updated Dec. 26, 2017

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Introduction

Vezda, simplified from the Russian звезда (zvezda) meaning *star*, is a free software package written in the Python programming language for solving shape reconstruction problems. In many areas of application, such as medical imaging, geophysical exploration, or noninvasive testing, one wants to locate an object or feature which is typically embedded within a host material and inaccessible to direct observation. By interrogating the enclosing material with a wave, one can noninvasively obtain measurements of the hidden object by recording the waves that scatter off it. The Vezda software package can estimate the shape and location of the unknown object using a modern technique from inverse scattering theory called the linear sampling method. The basic idea is to sample a region of space where you think the unknown object might be and use the information contained in the measured scattered waves to determine the shape and location of the hidden object.

Getting Started

The Vezda software package requires two distinct inputs: 1) the time signals recorded at each receiver containing the measured scattered waves caused by the presence of the scatterering object, and 2) the time signals containing the modeled Green function of the background medium between each sampling point and receiver. None of the Python codes in the Vezda software package will generate the "measured" scattered wave data (i.e., the first input requirement). You will need other software to obtain them. For the special case of a constant background medium, you may use the routines in 'FundamentalSolutions.py' to quickly compute the modeled Green function between each sampling point and receiver (i.e., the second input requirement). At present, only fundamental solutions to the two-dimensional wave equation are implemented. Three-dimensional fundamental solutions will be added shortly.

Included in the Vezda software package are fully working examples applied to various shape reconstruction problems. Each example contained in the 'examples' directory contains a 'Data' folder, a step-by-step 'INSTRUCTIONS.md' file, and an 'Images' folder with plots to the reconstruction problem.

Prerequisites

A working Python installation is necessary with both NumPy an SciPy libraries. I personally recommend using the Anaconda distribution if you do not already have one set up. It is perhaps the easiest and quickest way to get a working Python installation up and running with all the scientific and numeric libraries included. As Python is cross-platform, you can download an installation for Windows, macOS, and Linux.

DISCLAIMER: I am developing this software using Python 3 and have not attempted to make it backward compatible with Python 2. Since Python 2 is depricated and all advancement of language features and libraries are occurring in Python 3, I recommend using Python 3 anyway.

I also make use of the tqdm Python module in some of the code for displaying a progress bar from the command line. If you do not already have this module installed, you may do so with the command

```
pip install tqdm
```

or, if you have an Anaconda installation,

```
conda install tqdm
```

ONE

Using the code

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TWO

Plotting

Exploring the data and visualizations

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