3D Electromagnetic Field Visualization for STEM Outreach

UNH Space Science Department

Jake Nicholas, Travis Raynolds, Jacob Golas
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Introduction

Magnetic reconnection is a process in which plasma in the atmosphere disrupts magnetic field lines and causes a large amount of energy to be released as charged particles that can interfere with radio signals and GPS. Understanding the workings of reconnection in relation to these electromagnetic fields is an important topic of study.
This project's goal is to create a publicly accessible data visualization that illustrates the physical properties of electromagnetic flow fields in space. In doing so, we hope to increase interest in space-related STEM fields by making the material more understandable to interested STEM students and to the public. The visualization has been embedded within a website so that it is available to anyone with an internet connection. The application utilizes Python's Plotly graphing library for data visualizations, HTML/CSS/Javascript for the front-end, and Python Flask for server-side processing.

Deliverable

The end deliverable for this project is an application, contained within a web page, which allows users to view and interact with 3D electromagnetic flow fields. Users will have the option to choose specific data sets or request new data sets, and have that information displayed as an interactive 3D graph. Within the graph users can move, pan, rotate, and zoom to better explore and understand the nature of electromagnetic fields.

Functionality

Nonfunctional Requirements:

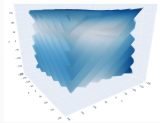
- Users are more interested in space science after using the software
- Web interface should be intuitive to use for those with no prior experience in the space science field

Functional Requirements:

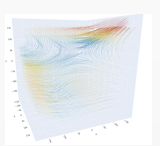
- Flow-field data is visualized via a 3D graph that can be traversed by the user
- Web-portal can provide easy visualization of random datasets, as well as specified datasets / locations on the graph.

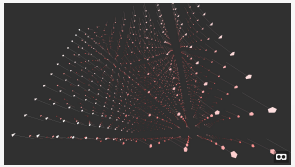
Prototypes

Draft: Cone plot, too dense



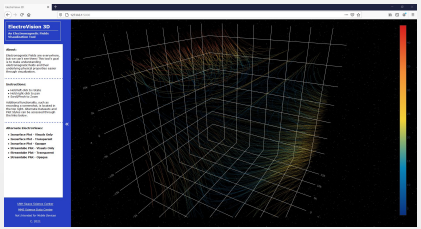
Final: Streamtube, shows trends better





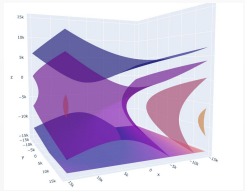
Virtual Reality visualization:
Early in development, not ready

Website

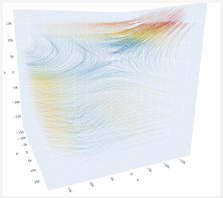


Data File (.csv) → **Parser (.py)**

Visualizations (Plotly)



Magnetic Field Isosurface (top), and Streamtube (bottom)



Flask Framework

Architecture & Design

Webpage:
The webpage component of this project has been built using HTML, CSS, JavaScript, and Python Flask. It is a single page application which utilizes Python Flask to construct its back-end framework and JavaScript to create reactive elements and menus.

- Visualization. embedded via <iframe> element
- Main menu contained in collapsible sidebar
- UX/UI designed with simplicity in mind

Visualization:
The data being visualized is contained within .csv files. Each entry in the dataset contains a coordinate point in 3D space represented by X, Y, and Z coordinates.

- Contains two 3D vector components for both the electric and magnetic field strength at each point.
- The .csv files are stored on the server, parsed by Python script
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References

MMS Website - https://lasp.colorado.edu/mms/sdc/public/

Contacts

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ElectroVision 3D - Electromagnetic Field Visualization for STEM Outreach

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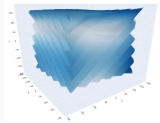

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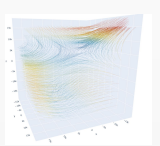

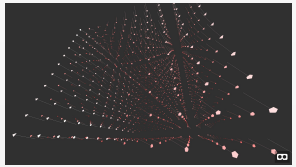

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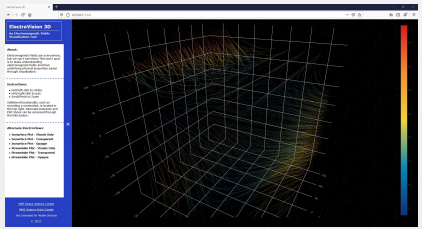

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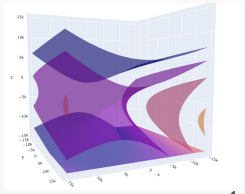

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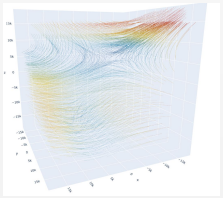

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