Aim: To visualize the magnetic field generated by a current flowing in a 3-petal loop using the Biot-Savart Law.

Objective:

1. Calculate the magnetic field components generated by a current-carrying loop.
2. Visualize the magnetic field in 3D space using interactive plots.

Summary: This project involves calculating the magnetic field generated by a current flowing counterclockwise in a 3-petal loop. The Biot-Savart Law is used to determine the magnetic field components at different points in space. The results are visualized using 3D interactive plots to provide a clear representation of the magnetic field distribution.

Tools and Libraries Used:

- **Python Libraries:** NumPy, Matplotlib, SciPy, Plotly, SymPy
- **Visualization:** Plotly for interactive 3D plotting

Procedure:

1. **Define the Current Loop:**
    - The loop is parameterized using a function l(φ)l(\phi)l(φ), where φ\phiφ is the angle. The loop is represented in the xy-plane with a 3-petal shape.
2. **Calculate the Magnetic Field Components:**
    - Use SymPy to symbolically compute the integrand of the Biot-Savart Law.
    - Define the magnetic field components BxB_xBx, ByB_yBy, and BzB_zBz by integrating the Biot-Savart Law expression over the loop.
3. **Evaluate the Magnetic Field:**
    - Compute the magnetic field at various points in a 3D volume using numerical integration with SciPy.
4. **Visualize the Results:**
    - Create a 3D meshgrid for the spatial domain.
    - Use Plotly to generate an interactive 3D plot of the magnetic field vectors.
    - Overlay the loop's shape on the plot for context.

Highlights:

- **Biot-Savart Law Implementation:** The project demonstrates the application of the Biot-Savart Law to compute the magnetic field generated by a complex current loop.
- **Interactive 3D Visualization:** Plotly is used to create an interactive 3D visualization of the magnetic field, providing a clear understanding of its spatial distribution.

- **Symbolic Computation with SymPy:** Symbolic differentiation and vector operations are performed using SymPy, showcasing its capability for handling complex integrals.

Conclusion: The project successfully calculates and visualizes the magnetic field produced by a current flowing in a 3-petal loop. The use of symbolic computation for the Biot-Savart Law and the interactive 3D visualization tools effectively illustrate the magnetic field's behavior, providing valuable insights into the field distribution around the loop.