Unlocking History: An Algorithm to Virtually Unfold 3D Computed Tomography Scans of Unopened Historical Documents

Jackson, Holly

In 1926, 2600 intricately folded letters from the 17th century were discovered. Opening the letters risks losing the folding patterns, breaking the seals, and destroying the text. Recently, researchers at a London university used high-resolution computed tomography (CT) scan machines to image a set of the letters. In my project, I developed an algorithm to virtually unfold the scans of the letters and reveal the text inside. Working with CT scans of these letters poses significant challenges including touching pages, intricate folding patterns, scatter from lead seals, double-sided text, and low ink-to-paper contrast. To account for this, my software approach combines point, line, and plane detection algorithms. I divide the 3D CT scans into thousands of 2D cross-sectional images. My point detection algorithm identifies candidate points on paper layers in the 2D cross-section. The line detection algorithm identifies each paper layer by fitting a smooth line along the approximate center. I proceed to link the lines in the orthogonal direction forming surfaces. Pixels from the 3D data are then extracted into planes using the coordinates from the identified surfaces. The data is plotted as a flat image allowing someone to read the text within. After eight months of concentrated algorithm development, I verified my algorithm's effectiveness by comparing my extracted images from one letter to photos of the real letter's interior. Finally, I virtually unfolded a letter that still remains closed and sealed to this day. The text can now be seen for the first time in over 300 years!

Awards Won:

Second Award of $2,000

Raytheon Technologies Corporation: Each winning project will receive $3,000 in shares of UTC common stock.

Association for Computing Machinery: Fourth Award of $200

IEEE Foundation: IEEE Foundation Second Place Award $600

National Security Agency Research Directorate : Second Place Award "Science of Security" of $1,000