The Pale Blue Dot

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**Abstract**

This report presents the implementation and outcomes of a digital image processing project aimed at recreating the iconic “Pale Blue Dot” image of Earth into a single pixel representing Earth in the “Pale Blue Dot” photo. The report details the methodology, experimentation, and results of the project, highlighting its significance in conveying the cosmic perspective of Earth’s place in the universe.

**1 Introduction**

The "Pale Blue Dot" image, immortalized by Carl Sagan, offers a profound perspective of Earth's insignificance in the vastness of space. However, translating the impact of this image into a comprehensible visual narrative presents challenges due to its abstract nature and low resolution. This project endeavors to bridge this gap by digitally recreating the journey from a detailed satellite image of Earth to the perspective depicted in the "Pale Blue Dot." Through meticulous image processing and manipulation, the project aims to evoke a sense of wonder and humility by illustrating Earth's diminutive presence in the cosmos.

**1.1 Related Work**

NASA has made significant efforts to enhance and disseminate the "Pale Blue Dot" image, recognizing its cultural and scientific significance. Enhanced versions of the image have been produced to better highlight the single light-blue pixel representing Earth amidst the vastness of space. These efforts aim to engage and educate the public about Earth's place in the universe, drawing inspiration from Carl Sagan's iconic "Pale Blue Dot" speech.

However, conveying the profound impact of the original image, particularly the emotional resonance it evoked in Dr. Sagan, presents a challenge. While astronomers and enthusiasts familiar with Sagan's work may appreciate the significance of the "Pale Blue Dot," reaching a broader audience requires innovative approaches in science communication. This project builds upon NASA's work by employing digital image processing techniques to create a dynamic visual narrative that captures the essence of Sagan's message. By simulating the journey from a detailed satellite image of Earth to its representation as a single pixel in the "Pale Blue Dot," this project endeavors to evoke a sense of wonder and humility, fostering a deeper understanding of humanity's place in the cosmos.

**2 The Proposed Algorithm**

The initial proposed algorithm employs erosion algorithms to gradually reduce the detail and resolution of the Earth image, simulating increasing distances. Furthermore, transformations of darkness are implemented to better simulate the “sunbeam” effect observed in the original photograph, enhancing the visual authenticity of the simulation. The resized and transformed Earth image is seamlessly blended with the original “Pale Blue Dot” image using alpha blending techniques, ensuring a smooth and coherent transition between the two representations. Throughout the process, each frame is annotated with the corresponding distance from Earth, providing essential context and enhancing the viewer’s understanding of the cosmic scale portrayed. By integrating these techniques, this algorithm encapsulates the emptiness of space and communicates the profound message of humanity’s place in the universe, echoing the sentiments expressed in Carl Sagan’s iconic “Pale Blue Dot” speech.

Given that erosion seemed to not fully accomplish this objective, we transitioned to using the ‘imresize’ function built into MATLAB that uses several algorithms, namely bilinear interpolation, to resize the image either larger or smaller (in our case smaller) to which we were able to generate all 6000 needed frames for our video. To help generate a better picture as also applied sharpening methods, by first applying a gaussian filter then using the ‘imsharpen’ function to generate a clearer picture of the resized Earth. Finally, we slowly shift the resized Earth toward the end destination of the ‘Pale Blue Dot’ pixel by first estimating the x,y coordinates of the pixel, and recentering the Earth toward a fraction closer with each new generated image. After generating our needed frames, we created a video showing the frames in reverse order to virtualize the expansion of the pale blue dot into Earth.

**3 Experiments**

The experiment evaluated the proposed algorithm’s performance in recreating the “Pale Blue Dot” image using a high-resolution satellite image of Earth. The algorithm was executed on MATLAB, leveraging image processing techniques to simulate the journey from Earth to the perspective depicted in the “Pale Blue Dot”. Parameters such as distance from Earth and blending factors were adjusted to optimize visual fidelity.

To assess the algorithm’s efficacy, qualitative and quantitative analyses were conducted. Qualitatively, the visual coherence and realism of the generated frames were evaluated. The progression of images, annotated with corresponding distances from Earth, was observed to ensure a smooth and accurate representation of the cosmic perspective.

Quantitatively, the video output was compared with the original “Pale Blue Dot” image to assess the algorithm’s accuracy in simulating the desired perspective. Metrics such as visual similarity, frame consistency, and overall coherence were considered.

**4 Conclusion**

The developed algorithm successfully achieves the goal of simulating the iconic “Pale Blue Dot” image using a modern satellite image of Earth. Through a combination of resizing, sharpening, blending, and annotating techniques, the algorithm effectively conveys the cosmic perspective depicted in the original photograph. The resulting video animation captures the essence of Earth’s significance in the vastness of space, evoking a sense of awe and humility reminiscent of Carl Sagan’s renowned message.

Moving forward, there are several avenues for exploration and improvement. Firstly, refinements to the algorithm’s parameters and techniques could enhance the visual fidelity and realism of the simulation. Additionally, the integration of machine learning techniques may offer opportunities to automate and optimize certain aspects of the algorithm to real-time video processing could broaden its utility and impact.

**References**

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