SENIOR CAPSTONE RESEARCH PAPER

Interactive Digital Camera Application

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Abstract

21st Century learning, understanding, and thinking is centric on the Internet. People are driven to learning via accessibility, ease of use, efficiency, helpfulness, timeliness, interactivity, and application. The digital camera is a major object of interest today. It is used more than ever. Interest in photography and the digital camera has increased proportionally. Using the knowledge developed in the past four years as an Imaging and Photography Student at the Rochester Institute of Technology, I hope to combine the interactive and accessible educational methods of web applications with the digital camera. Linking these two considerations will bring forth an educational and application-based tool that is the first of it's kind: an easy-to-use interactive 3D digital camera website application for higher education and industry applications in the areas of imaging, photography, electronics, and optics.

Fundamental Problem

Higher education in the 21st century has progressively become more and more technology-centric and dependent. Students and professionals rely on technology as a primary learning tool for scientific and engineering based applications and research. The Internet is a hub for education and learning- it is broadly accessible, easy to use, precise and efficient. Web-based education is a direct reflection of the platform on which it exists- it is visually appealing, easy-to-understand and access, helpful in answering specific questions quickly, interactive, and applicable. These resources are often presented in the form of a website, in a blog, as an application, or via instructional video or tutorial. The emphasis on hands-on interactivity in learning, both on and off the web, has also increased, as flourishing fields like computer science and engineering require knowledge of both hardware and software.

Today, digital photography and imaging is more relevant, desired and necessary than ever before. The advent of mobile phone cameras triggered a drastic increase in the use and general interest in cameras and photography by consumers, artists, engineers, scientists, hobbyists, etc. (Fig. 1)

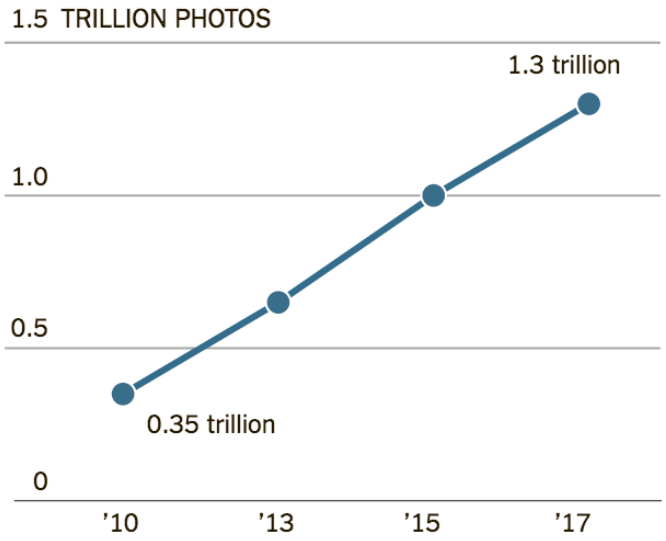

Figure 1: Digital Photos Taken Worldwide
*(*Data after 2013 are forecasts)* via New York Times

As a student in the Imaging & Photographic Technology program, I have dedicated the past four years of my studies to the imaging system- how it works, what it does, why it functions a specific way- everything. The digital camera is changing in design, functionality, capability, and usage everyday. While general interest in and usage of the digital camera has increased, there is a major lack in understanding the camera itself. There are thousands of resources on the internet that can teach people about how digital cameras work, how their iPhone camera works, how optics work, how sensors work, etc., but, there is no web-based educational resource that interactively teach people how the entire device that they are using every single day *actually works*.

Sampling of Useful Applications for This Capstone Project:

- Supplement to courses in Physics, imaging, photography, electrical, mechanical and software engineering, medical imaging for high school and college students

- Use in industries in the areas of imaging, optics, photography, engineering, and photonics

- Increased general knowledge of camera capabilities (decreased reliance on post-production, increased interest in maximizing camera's direct capabilities)

By building an easy-to-use, interactive 3D model of an entire imaging system embedded into an interactive web application, the world would have access to an all-encompassing, accessible application and hands-on based learning tool. There is no one cohesive website or application that interactively regards the camera as a complex system (optics and electronics). Interactively emphasizing the roles of every individual functioning component within a digital camera will help to emphasize the complexity

of imaging systems, and more importantly, how their construction can be specifically and intricately modified to suit any specific, desired application. This application would compile information from various websites into one interactive learning tool- putting everything people need and/or want to know about the digital camera on one accessible platform, cohesive with today's technology-centric education.

In addition to benefitting the general public and industry, I will also benefit greatly by creating this application. I will be compiling, reinforcing, and expanding upon the knowledge I have gained throughout my college career. I will also develop useful skills in new areas (3D modeling, web development and programming, education, technical communication, etc.

Historical Work & Current Approaches

Building a broad scope, web-based interactive tool is not an easy task by any means. Pursuing such a complex opportunity requires, in addition to the vast knowledge of digital cameras, background in web development and programming, 3D modeling and animation, and 3D interactivity. Because of this, there are not very many examples of work similar to this capstone project (further emphasizing the importance of pursuing and creating this resource).

But, there is one exceptionally noteworthy application of using web interactivity to educate and instruct on a specific, important topic, seen in biodigital.com. Biodigital.com was created by NYU's School of Medicine. Biodigitial.com is an award-winning education and training platform referred to as an "interactive 3D map of the human body [which] makes it easy to visualize data, anatomy, disease and treatments in any web or mobile application." ABC News referred to the website as "Google Earth meets the human body" and Wired Magazine called it "A Digital Revolution for Studying Human Anatomy."

NYU's School of Medicine understands that the medical profession requires a very extensive "knowledge of human anatomy and physiology," but the amount of time spent in anatomy-based classes for all medical students has decreased by about 50% over time. NYU's School of Medicine wanted to compensate for and supplement this loss by creating a "technologically advanced solution to increase exposure for their students and [to] maximize educational effectiveness."

The solution for NYU was to modernize their curriculum to "learner-centered, leveraging the BioDigitial Human as a cloud-based virtual anatomy resource," allowing students to continue learning in, outside, and beyond their course(s). The teachers and staff at NYU's School of Medicine compiled and published custom dissection bookmarks and research, embedding them into this one, online "learning management system."

Biodigital.com “provided students an experiential learning method, all on a digital platform that can be virtually anywhere. Medical students now have the opportunity to repeat dissections, access detailed information about different parts of the body, and quiz themselves on a custom regional view.”

Proposal/Project Goal(s)

I. Project Outline

What: An easy-to-use interactive 3D model of a standard DSLR camera and corresponding lens embedded into a web application

Figure 2: Example of 3D Anatomical Model of Digital Imaging System

We will 3D model a DSLR camera (typical CMOS imaging system configuration) and lens (standard 24-70mm) in CAD software that is compatible with web interactivity and embed. All individual, functional components within both the lens and camera will be included in the 3D model.

The 3D model will be embedded into a web application using Javascript or any corresponding programming language to make the 3D model interactive: able to rotate, click-on, and zoom in on model. Both the lens barrel and the camera body, once clicked,

will expand to reveal interior anatomy (all individual functional components within) (Fig. 3)

Figure 3: Example of Expanded View of Lens

Once expanded, each individual component in view will be clickable/interactive. When an individual component is clicked, a corresponding information block will appear. This information block will define the component and explain it's role in the scheme of entire imaging system, describe useful applications for specific component, discuss how it's individual abilities can be altered for modified functionality, and disclose important advantages & disadvantages (Fig. 4)

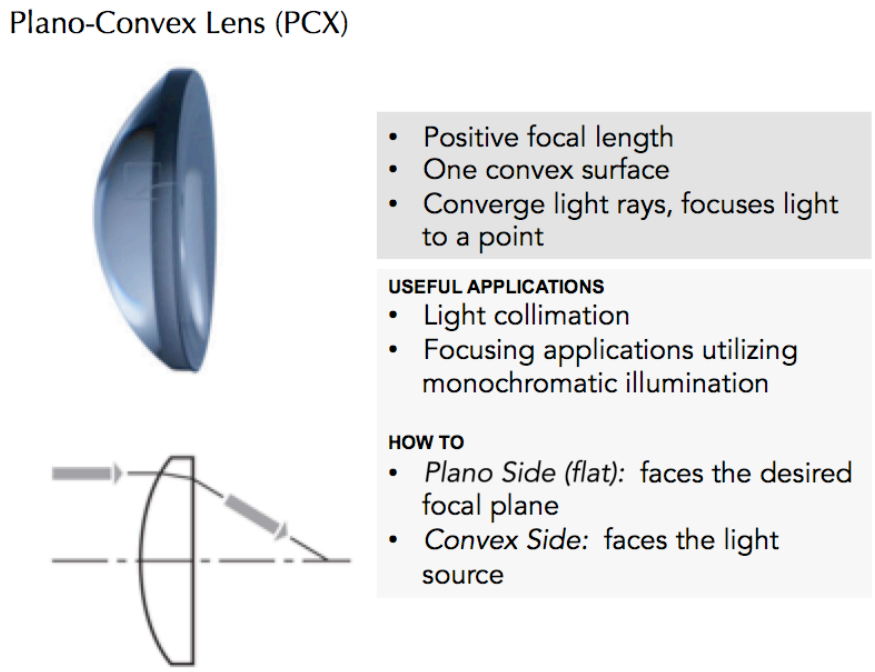

Figure 4: Corresponding information for a Plano-Convex Lens (appears when the 3D model of the component is clicked)

Why: Supplemental educational and application tool for high school and college students, and industries in the areas of imaging, photography and optics

Who: Reilly Hogue and I will be working on this project as a team. Reilly Hogue will be 3D modeling and researching the electronics of the device (camera and corresponding individual components) and I will be doing the same for the optics (lens).

II. Abstract Goals (Overall)

1. Teach audience about how a standard DSLR works (optics and electronics)
2. Emphasize roles of individual functioning components to reinforce complexity of imaging systems
3. Use 3D model of digital imaging system to illustrate capabilities (how modifying components can alter image appearance, for example)

III. Abstract Personal Goals

1. Come out of the project with better understanding of 3D modeling, JavaScript/web embed, interactivity as a learning method

2. Better understand lens geometries, camera, how it all works

3. Understand how to work with people, reach out to companies for ideas/feedback professionally

IV. Required Tangible Goals

The minimum achieved tangible goals required to declare the project "complete":

1. Finalized website with 3D model (standard CMOS camera configuration with 24-70mm lens)

    - **Personal Goal:** One 24-70mm DSLR Lens 3D model containing all individual functional components with corresponding research per each individual component

2. All components interactive and paired with proper, necessary information

V. Supplemental Tangible Goals (Overall)

1. Interactive Glossary
2. Technical Tools/calculators (focal length, MTF/SFR, aperture, etc.)
3. Photograph of one scene as a standard (show at different focal lengths, sensor sizes, etc.)
4. Upcoming Technologies

VI. Supplemental Tangible Goals (Personal/Lens Specific)

1. Ray Trace through the entire lens system (white light, RGB bands of light, IR, UV, etc.)
2. Model multiple lenses (24-70mm, 100mm, 50mm, 16-35mm, etc.)- see how affects image appearance, ray path changes
3. Image Appearance – display how image appearance changes per different lenses
4. Aberration – aberration ray trace/interactive tool
5. Depth of Field Interactive tool
6. Coatings
7. Zoom/focusing (image stabilization, manual focus vs. auto focus, interactive zoom)

Challenges

1. 3D Modeling

Reilly and I have very little background in 3D modeling, so modeling such a complex system will not be easy. We are in contact with RIT's 3DDD program, discussing the best software/methods for modeling this system accurately and efficiently.

2. Web Embed

Have recruited Web Development students as well as Game Design and Development students who are familiar with web embed and interactivity in web.

Bibliography and other references

- www.biodigital.com
- http://www.nytimes.com/2015/07/23/arts/international/photos-photos-everywhere.html?_r=0

Interactivity Inspiration:

- http://1stwebdesigner.com/3d-websites/
- http://www.solarsystemscope.com/
- http://visualizer.halowaypoint.com/
- https://despreneur.com/interactive-websites/

Mentor Choices and Reasoning

1. **Bob Rose**

Bob Rose has years of industry experience that could help us to get in touch with companies (will help us in determining what is important to include, what matters to people in industry, to learn from/utilize resources from industry, etc.). Bob also understands the customer/marketing perspective, which is extremely important in developing our project for consumer/industry/educational access. Bob is very practical and organized in managing long-term projects, which are attributes that are crucial to have in a mentor when working on such a detailed project.

2. **Nanette Salvaggio**

Nanette Salvaggio has vast knowledge of digital imaging systems and technologies, pairing and supplementing our research and understanding of technical explanations of components. Is very structured and organized, and is honest.

3. **Dan Hughes**

Dan Hughes is eager, passionate, and willing. He is creative in coming up with useful and new innovative ideas and projects- attributes which would pair well with our pursuit of a new method of teaching, using and understanding the digital camera.