Historical Manuscript Imaging
Product Requirements Document

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Document Number 00002

Revisions Level	Date
A	11-09-2016

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Rev	Description	Date	Authorization
A	Fourth PRD	12-5-2016	GLR

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Introduction

The historical manuscript imaging is a customer driven product. As such, its design inputs are derived from interactions with customers from the University of Rochester English department and rare books.

Customer Information:

The customers are Prof. Gregory Heyworth (UR, English Department), ~~Prof. Roger Easton (RIT)~~ and Jessica Lacher-Feldman, Assistant Dean and Director of Rare Books and Special Collections at the library. The faculty advisor is Professor Stroud, from Institute of Optics, UR.

Vision:

The customer would like to develop a system for imaging of the "tightly bound" manuscripts with at most a 30 degree opening.

This system should also include a book holder which will hold the book with the binding parallel to the ground, and automatically turn the pages for imaging. What's more, the customer would also like to make this system to image the page down to the binding, if possible. At this time the customer would like our group to explore the use of prisms; a single prism that is able to project an image of an entire page of the book.

Contextual Research:

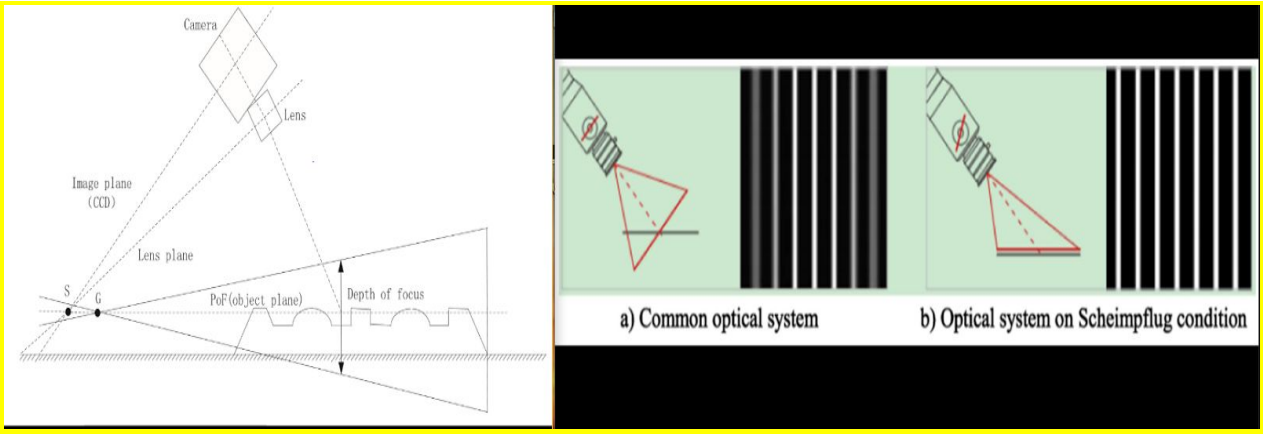
The biggest limitation/surprise at this point is the angle that the book can be opened; a 30 degree opening was measured and the space available between pages to work

with is far less than initially believed, about 2mm horizontal at 4mm vertical from binding. Contrary to initial thoughts, we have found no bending in the binding of various sized books opened to 30 degrees, yet.

- Different prisms with varying geometric orientations were placed into book
- Small diameter lens' were also used for imaging characteristics. This has led us to the possibility of some sort of small lenslet array that can pull and image the length of book in one sweep, this array would need to be adjustable in order to make an image from the deepest depths of the binding accessible.
- Plane mirror

There is the possibility of little to no light in the binding so depending on the system there may be a need for a light source, adding additional geometric constraints.

- We are exploring the viability of a small camera system as well as a laser scanning system.
- Scheimpflug Condition- when the object plane is not parallel with the image and lens plane much of the image is defocused; by rotating the lens plane to the image (sensor) plane the plane of focus(DoF) can be oriented to the object plane.



Mei, Q., Gao, J., Lin, H., Chen, Y., He, Y., Wang, W., . . . Chen, X. (2016). Structure light telecentric stereoscopic vision 3D measurement system based on scheimpflug condition. *Optics and Lasers in Engineering, 86*, 83-91. doi:10.1016/j.optlaseng.2016.05.021

Calculation of Prism

Length of base	37cm
Height	68.5cm

Degree Of angle	30 degree

Elements We are not Responsible For

- The book holder for the manuscript
- Element which turns pages of the book
- Characterization of the book, such as physical constraints

Team Role:

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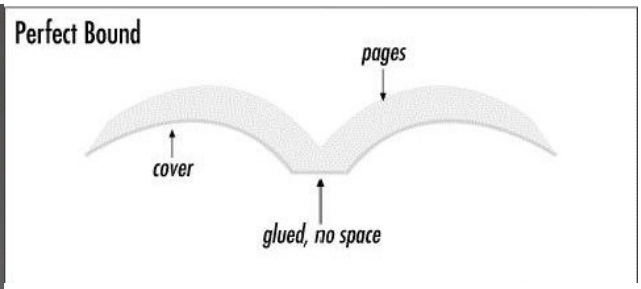
Environment/Book Specifications:

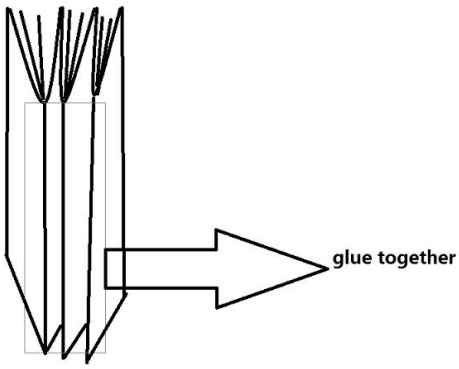
Due to the delicate nature of the samples the environment must remain as close to the rare books environment as possible, in terms of temperature and humidity.

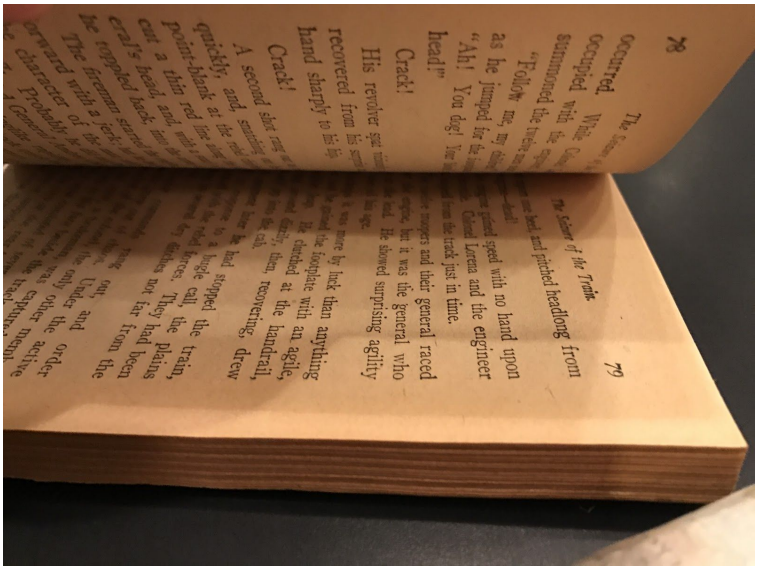
The surfaces of the instrument in contact with the samples should be easily cleanable, and will not damage the sample.

Book Specifications:

Topics	Data
Binding style	Perfect Binding
Cover style	Soft cover
Book size	7’’ × 5’’(all same size)
Pages	Around 250-350 pages/book
Font size	10







Regulatory Issues:

What are the regulations for imaging rare books?

Fitness for use:

The system will:

- **Image the tight-bound books which can not be opened past 30 degrees**
- Turn the pages of books automatically
- Hold the books without bending or damaging books
- Process the image to get rid of distortion, so that the final image will be easily readable, using as little image processing as possible requested
- Use a laser(if necessary) that operates around 509 nm to ensure no damage is induced to materials.
- **Capable of imaging of books with varying dimensions (Multiple Prisms?)**
- **Should be production robust: Doesn't require frequent recalibration. Requires low maintenance. Relatively insensitive to vibration.**

It is desirable that:

- Capable of imaging the binding part of the books
- Costs less. (No specific budget given)
- System images two pages simultaneously

Options Moving Forward

- Our customer Professor Heyworth recommends that at a physical element inserted into the binding may come into contact with the pages. However, customer Jessica Lacher-Feldman, prefers that no physical element of the imaging device can contact the pages of the book. We will need to get both customers together to discuss and come to a conclusion on this issue.
- Investigate the possibility of manufacturing a prism with a large enough field of view to image an entire page all at once. There is also the possibility we will need to look into the capabilities of imaging with a prism that is not in contact with the object, and if the geometry of the object will allow for imaging to the binding when not in contact.
- We decided to abandon the terahertz imaging technique due to high cost, a preference for non-transmissive light, and the limit on the number of pages which can be imaged.

Timeline

By PRD Review 1	• Assigned the responsibility for each teammate

	● Met our customer and clarified the project that we need to do ● Got some ideas for this project
By PRD Review 2	● Decided what to focus on in the advancement of the project. ● Researched and analyzed the previous two ideas for this project (prism, camera). ● Came out some new ideas
By PRD Review 3	● Eliminated terahertz idea ● Decided upon prism approach ● Found book specifications ● Decided upon mechanical elements we are not responsible ● Met with professors and PhD students for advice
By 12/5/2016	● Present final Project Review Document in class ● Calculated dimensions of necessary prism size ● Create schedule for spring semester in order to test/examine all realistic prism imaging possibilities
January	● Month of testing design prototypes ● First order estimates of systems.
February	● Further design and implementation of system
March	● Finalize system design ● Present to customer
April	● Final test of imaging system ● Error checking