Bar Harbor Project Center
Trail View: Acadia National Park

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Abstract

Acadia National Park is home to over 125 miles of trails in coastal Maine. Many visitors of this park come to hike these diverse trails. A pressing goal of the park is nature preservation and public outreach. The goal of the Trail View project was to document and make these trails more accessible using 360-degree panoramic photos. These photos were compiled and geotagged to be assembled online in virtual tours. This allows potential hikers and people with disabilities to view the trails. Previous WPI Trail View teams have demonstrated proof of concept. However, due to limitations in technology and methodology they only recorded 7.2 miles of trails. Building on their foundation, this year's team used cameras that captured 360-degree photos. Using this method, 64.6 miles of trails were recorded. These trail views will be made available on the Acadia National Park website.

Executive Summary

The National Park Service (NPS) is dedicated to preserving the National Parks while also making them accessible to the public. Acadia National Park has the most visitors per square mile. This causes them to strive with maintaining the park while also encouraging involvement of the public. In order to set a precedent for future generations of park visitors and employees, the National Park Service released *A Call to Action*. *A Call to Action* summarizes the goals of the National Parks as they reach their first centennial and look forward to the next hundred years of park service.

In 2012, the first WPI Trail View project was created to meet three of the Action Points in *A Call to Action*. These Action Points were "Parks for the People", "Next Generation Stewards", and "Go Digital". The 2012 goal was to integrate the public into the full experience of being in Acadia through technology. The main focus was panoramic photography and natural data using an interactive, informative interface. Though the 2012 team did create an interface, the manual panoramic stitching and data acquisition was time-consuming. The 2013 and 2014 Trail View years turned their focus to the spherical photography. Spherical photography allows the user to pan around an image this is wrapped in a sphere around the user. By linking these pictures together one can have a "virtual tour" of the trails of Acadia National Park. However, the lack of automatic spherical stitching technology in previous years led to very time consuming post production.

The goal for the 2015 Trail View team was to progress the project by focusing on documenting as many trails as possible and leave the process of creating tours to future teams. Over the years, new technology has allowed the teams to move forward in the project at ever

increasing speeds. This year was no exception. Through the use of new technology, the 2015 Trail View team was able to document 64.5 miles of trail in Acadia National Park. In addition, interactive tours were created to show the feasibility of moving the content online in future years. These tours are similar to Google Streetview in their interface.

There are some recommendations for the next year trail view. The first is to finish the project. Most of the trails were completed in 7 weeks, so completion of all trails is an obtainable goal. The team recommends a camera that charges while in use. This eliminates problems with battery life. Additionally, the team recommends investigating more advanced cameras. The "bubl" is an example. The team thinks that virtual reality could be a great addition to the project. This is because the technology is rapidly improving and Acadia National Park could be the first to have it.

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Chapter 1: Introduction

One of the prominent areas of Maine's spectacular rugged coast is Acadia National Park. The park is operated by the National Park Service. They are dedicated to preserving and providing access to America's natural resources. For their second century of service, they are renewing their emphasis on stewardship and engagement. This renewal is captured by the National Park Service's *A Call to Action.*

A Call to Action specifies a need to increase public accessibility. Hiking trails are one of the primary means of public access to the park. They allow people to be surrounded by nature with minimal harm to the environment. Though the park has many miles of beautiful trail, not everyone can experience them. Individuals with disabilities may not be able to hike these trails. Currently there is no system to bring the parks to those unable to hike them. A digital trail viewing system would allow anyone to view these trails. This means that people without physical access to trails would still be able to appreciate their beauty.

The Trail View project was established to service Acadia National Park. Specifically, the purpose of this project was to increase the accessibility of Acadia's trails. The Trail View 2015 project team was thus following the goals of *A Call to Action* to provide solutions for the National Park Service. This was done by creating virtual trail maps with photography. By integrating outreach and technology, these virtual trails were made accessible on the internet. The project allows more of the public to experience Acadia National Park. In photographing these trails, another problem was addressed. These maps also act as historical records, providing a snapshot of the trails for generations to come.

The Trail View project has been operating since 2012. Previous years' work provided a foundation of knowledge and research for creating trail views. However, the best technology was not available to them. A substantial number of the trails went unmapped. More advanced equipment was more efficient and, in turn, allowed more trails to be mapped. 64.5 miles of Acadia National Park were recorded. These trail views are supplemented with additional pictures at specific points of interest.

The project goal was to create interactive virtual trails to raise awareness for the park. Using the lessons learned from previous years, the team efficiently created trail views. This project raised awareness for the park by allowing the public to view the park trails. This coincides with Acadia's goal of showcasing the beauty of the park without damaging the environment.

Chapter 2: Literature Review

2.1 National Park History

A National Park is land owned and protected by the National Government. National Parks are established to preserve the "natural beauty or its importance to history or science." (Merriam-Webster, 2015). The first National Park established was Yellowstone National Park in 1872. The establishment of this park sparked a global movement to preserve nature and history. Keeping with this global trend, President Woodrow Wilson approved the creation of the National Park Service in 1916 (National Park Service, 2015).

2.2 National Park Service

The National Park Service (NPS) was created to protect and maintain the National Parks established in the United States. In order to accomplish this, the National Park Service recently declared a call to action. The National Park Service's "A Call to Action" was released in 2011. Its goal is to reflect on their past accomplishments and prepare for a new century of park service. Specifically, the National Park Service intends to expand their contributions to society through public outreach (National Park Service, 2011). In order to achieve this goal they have set forth 39 Action Points. These Action Points are specific methods for the National Parks to achieve the broad goal.

The National Park Service's mission is stewardship and engagement. As the park service strives to make the parks more accessible, they are met with many challenges. For example, with more hikers on the trails, the preservation of nature becomes more difficult. Hikers without a good understanding of the local ecosystems can inadvertently cause trail damage. Providing knowledge

and an appreciation for nature can help prevent these effects (Ferreira, 1998). The NPS is looking for ways to assure this knowledge and appreciation (National Park Service, 2011).

Even with the influx of new hikers, there are many people who are unable to hike and appreciate the trails (Bialeschki, 1988). Reaching out to these people is an important part of the NPS's Call To Action (National Park Service, 2011). This can be done through the use of technology. Bringing natural beauty to the digital age will affect the public's understanding of nature and our national parks. This is one of the ways that the NPS is solving the problems it faces. Digital public outreach can affect the views of people all over the world. By shaping the views of not just those who hike park trails, a greater impact can be made (Godbey, 1985).

The Trail View project addressed these needs by focusing on three of *A Call to Action*'s points: Parks for the People (point 5), Next Generation Stewards (point 7), and Go Digital (point 17). 'Parks for the People' is a call to create more relationships with diverse communities. 'Next Generation Stewards' encourages outreach to the younger generation through interactive media. And 'Go Digital' shows the park's interest in reaching new audiences through technology.

2.3 Acadia National Park:

2.3.1 Origin:

Mount Desert Island began as a trading port due to its convenient location. Over the course of three centuries it became a paradise of leisure and natural preservation. After the American Civil War, settlers began to build the town called Eden in the Eastern part of the island. Toward 1900, wealthy aristocrats from the larger cities established grandiose summer "cottages". They were enticed by the proclamations of natural retreat and the island's growing popularity. The embattled beliefs of the locals and wealthy summer residents were characteristic in local decisions (Kaiser,

2010). Springing into prominence in the 1860's, the now Bar Harbor grew from "a small village to a vastly popular summer resort with hotels accommodating thousands." (Hill, 1996)

The main attraction of Mount Desert Island was natural recreation. Whether hiking, boating, or riding, the island served as an escape from industrialized cities. Locals, notably George Dorr, sought to preserve and donate the lands of Mount Desert Island to the National Parks. Through Dorr's work with Congressmen, Dorr's extensive estate was put under preservation. Perhaps the park's greatest benefactor was Rockefeller Jr., donating much of the land that currently makes up the Park today. Acadia Park reached national status in 1919 and continued to grow through the help of locals and benefactors (Hill, 1996). Acadia National Park became the first national park established east of the Mississippi River (National Park Service, 2015).

With over 45,000 acres of land, Acadia National Park is home to 125 miles of beautiful trails (National Park Service, 2011). These trails attract many hikers every year. While trails make the natural beauty of the park accessible, it also makes it more difficult to preserve the park (Hammitt, 1998). The Call to Action touches on this difficulty of balancing preservation and accessibility (National Park Service, 2011).

The Trail View project helped the Park's goal of making their conservations more accessible. The rugged terrain and remote location make accessibility of Acadia National Park a dilemma. There are some people who, despite their wishes, are unable to hike. Whether due to disability, distance, or simply a lack of time, these people find the park inaccessible (Bialeschki, 1988).

2.3.2 The Champlain Society:

French explorer Samuel de Champlain surveyed much of the Eastern coast of Canada for France. Champlain christened the 'île des Monts Déserts' (Mount Desert Island) in 1604. His explorations in present-day Acadia National Park inspired a society named after him. The Champlain Society was formed during the summer of 1882 when a group of Harvard College undergraduates camped on Mount Desert Island. They spent their time collecting flora, fauna, and geological samples. They also enjoyed activities such as sailing, rowing, and socializing (Maine Memory Network, 2015). All of these activities are documented in the Champlain Society Logbooks. These log books are important because they record the natural history of the island in the 1880s. Scientists have used these log books to document the effects of climate change and land use on Mount Desert Island (Smithsonian History, 2012).

Another aspect of the log books that makes them particularly interesting is the fact that they chronicle the origins of Acadia National Park. On August 9, 1882 an entry records a discussion between two men in Northeast Harbor who proposed "a society to protect the natural beauties of this part of the island" (Champlain Society, 1882).

This society, The Trustees of Reservations in Massachusetts, was formed 19 years later under the guidance of Harvard's President Charles Eliot. Charles Eliot's son had been a part of the Champlain Society and influenced his father greatly in this decision. This society acquired the first land that eventually became Acadia National Park (Catherine Schmitt, 2015).

2.3.3 Carriage Roads:

Acadia's carriage roads were the start to making the island's natural beauty accessible, even before the national park was established. These roads were originally constructed on land donated to the park by John Rockefeller Jr. In the era before the popularization of the automobile,

Rockefeller Jr. used these roads to experience nature from a horse-drawn carriage. These pathways crisscross from Bar Harbor to Seal Harbor, providing views of Eagle Lake and Jordan Pond along the way. Seventeen stone bridges serve these roads, each one designed differently and built by hand. Rockefeller's carriage roads fell into disrepair after his death, but were rescued by the non-profit Friends of Acadia. They are now fully restored. The carriage road's historical ties to one of the park's greatest benefactors makes them an important piece of the park's distinct personality (Kaiser, 2010).

2.3.4 Historical Preservation:

The Champlain Society trails and the carriage roads are parts of Acadia's history that should not be forgotten. Keeping digital records of these trails coincides with the National Park Service's goals of preserving nature and promoting engagement (National Park Service, 2011). Future generations will be able to access these records and examine how the park has changed.

This ability to see the past will also benefit scientists studying changes in flora and fauna. One example of change being observed is the recent loss of plant species in Acadia. By examining the Champlain logbooks scientists have determined that one fifth of the plant species that were common in the 19th century have since disappeared from the park (Smithsonian History, 2012). A natural history of the current state of the park will allow scientists to further study the local ecology as well as the effects of climate change and land use.

2.4 Cyber Tourism:

With the use of a new camera technology, better records can be taken of today's trails. Instead of journals or logbooks, photographic documentation of the trails were taken. These photographs can be displayed online to further the NPS' goal of public outreach and preservation.

One of these technologies is cyber tourism. Cyber tourism is defined as the application of digital technologies, such as geographical applications of tools, graphic instruments and simulations, to achieve a tourist experience (Glenn F. 2005). This information can be arranged in the form of a digital tour. Once digitized, these tours can be displayed on the internet for broader access. The nature of an online tour allows access to all, regardless of the time of year or global position of the viewer. This improved accessibility will also address the challenge of public outreach. These tours serve to increase public knowledge of and interest in the parks. Digital trails will also preserve the state of the national parks, encapsulating the parks as they are today (Goncalves, 2007).

2.4.1 Examples of Tours

2.4.1.1 Google Street View:

Google Street View is a technology that provides panoramic pictures from many positions along streets and paths. It began in the United States in 2007 and has spread to much of the globe. A majority of images are taken from an apparatus mounted to the top of a car. Areas without traditional road access are imaged with different equipment, such as tricycle or trolley. The images are then stitched together to create the panorama data. Locational data is added to these via a Global Positioning System, a wheel speed sensor and inertial navigation sensor data. Faces and license plates are blurred for privacy. People can also request their home be blurred. Google has expanded into indoors locations as well, providing views inside local business such as cafes or shops (Google, “Maps”, 2015). Users can also look at street views from past years (The Guardian, 2014). All of this taken together creates StreetView.

Street View has expanded to include Google’s Treks. This project has the goal of making the world’s most famous monuments and nature locations available for anyone to view online.

This makes the world most wondrous locations more accessible. More people can experience the Arc de Triomphe or Great Wall China (Google, “About- Google Maps”, 2015).

2.4.1.2 Nature Valley Trail View

Nature Valley is a company that makes food products for hikers, including granola bars. The company is committed to nature and preserving it. To further this goal, Nature Valley formed a partnership with the National Parks Conservation Association. They wanted digital platform that encourages outdoor exploration and education. Thus, Nature Valley created a Trail View of four American parks: Sequoia, The Grand Canyon, Great Smokies and Yellowstone for a total of over 300 miles of trails.

A small crew of 4-8 people hiked the trails at the four national parks over a two month period. They were led by editors from Backpacker Magazine. Backpacker Magazine is accepted as an expert on national park trails, hiking skills and backcountry ethics. Together, they hiked an average of 6 to 13 miles a day. The camera they used was the Dodeca 2360. This camera takes 360 degree photos and has 11 lenses. It was mounted to the hikers backpack above the head. The camera mount was designed to offset motion from the hiker (Nature Valley, 2014). This approach to trails and their video documentation directly inspired the Acadia National Park Trail View team.

Chapter 3: Methodology

The National Park system serves to protect America's nature while incorporating the public. The Park system maintains a balance between preservation and accessibility. The park's trails embody this balance by allowing people to traverse the park's landscape without harming the environment. To make these trails more accessible, virtual documentation can be used to engage people worldwide.

3.1 Trail Selection

The goal of recording over 100 miles of trails had limitations. The primary limitation was time. Due to a lack of time, the priority of each trail was determined. By prioritizing, the final work was comprised of the trails that most people want to view. To select these trails for mapping, several different groups were informally surveyed.

The park's staff is the first group that was surveyed. The Trail View team started with short unstructured interviews to get an idea of which trails and areas of the park are most popular. These informal interviews were useful to get a qualitative understanding of which areas of the park are considered to be the most beautiful and important, so that a record is taken.

The second demographic to be surveyed was the hikers themselves. Unstructured interviews gave an alternate perspective to the park staff's opinion on specific trails. The Trail View team was able to record the views of people who interact with the park on a non-professional basis. This allowed the team to compare the perspectives of park officials and park visitors. In the case of contrasting opinions regarding a trail or area, this indicated a need for more research about

the area to ensure the team has a good understanding. Getting this second opinion on the park and trails provided a better understanding of what needed to be mapped.

3.2 Equipment Selection

Once a list of trails was created and information was collected, the team had to assemble the proper equipment in order to document the trails. The criteria for selecting the camera, tripod, GPS, and software were determined based on the needs of the project and suggestions from previous project teams.

3.2.1 Camera Selection

Camera selection required two criteria: quality of photos and ease of use. The photos needed to accurately depict the trails with enough detail to engage the viewer in the environment. The camera needed to have an intuitive control scheme and the photos it takes must integrate easily with panoramic tour software.

The camera that best meets these requirements was the Ricoh Theta (Figure 1). The Ricoh Theta is a camera with a spherical lens that captures an entire 360 degree panoramic photo with one click of a button. The photos taken by this camera are of high enough quality to allow for a detailed and engaging image (Figure 2). The camera can be controlled using a cellphone application. The application allows the user to take a picture while standing far from the camera itself. By standing far from the camera, the person taking the picture will not be a distraction to the viewer. This increases the ease of use and minimizes the space in the picture that will be taken up by people and equipment. Because the camera takes a panoramic picture in one shot, the amount of post-production effort was less than previous years'. Pictures did not need to be stitched together and were easily integrated into any panoramic tour software.

In order to stabilize the camera and keep it at the correct height the team needed a tripod. The team used a lightweight Ravelli tripod in an effort to reduce the overall equipment weight.

Figure 1: Ricoh Theta Camera

Figure 2: Panoramic picture taken with the Ricoh Theta camera

3.2.2 GPS Selection

In a digital trail viewer, the user must be able to select a viewing location. In order for this to be possible, the location of each image must be recorded. The most accurate way to determine this information is through use of the Global Positioning System (GPS). The Ricoh

Theta phone application automatically tagged each photograph's location with GPS data. This meant that the team did not have to carry a dedicated GPS unit and allowed a more seamless postproduction process. The GPS datapoint for each photo provided the precise coordinates of the location of the image. In the digital trail viewer, this allowed the user to know exactly where each image was taken. This information was displayed to the Trail View user through the software by associating each image with a waypoint coordinate.

3.2.3 Software Selection

Once all of the images and their GPS data had been compiled, they needed to be made accessible to the public. In order to make these images accessible and interactive, they were compiled into a virtual tour. This process required the use of software to properly format the images. A criteria for software selection is the requisite time to learn and operate. So, the team required a software which is both in-depth and easy to use. The team has selected Panotour Pro 2.3 as our software because it fulfills both requirements. The software effectively formats the images into spheres that the user can "look around" in. It also allowed GPS waypoints to be specified for each image. Though it has many features, the simplicity of user interface allowed compiling in a very short amount of time.

3.3 Photo Geotagging

The Ricoh Theta names each photo a number. Each new photo's name is the previous plus one. When the photos are taken off the camera, the user is then able to see the chronological order in which the photos were taken. For our purposes, though, this was not good enough. The National Park Service needed to be able to associate the photos with GPS coordinates.

When a photo is taken on the Ricoh Theta from a phone, if the phone has GPS information available, the photo will also have that data. The photo will have hidden information stored on it, called exif data. In order for the park to easily access this GPS information, code was written to rename the files to the GPS data. The GPS exif data is stored in a slightly different system than typical angular latitude and longitude, so it must also be converted to the NPS's preferred format. Below is pseudocode to show the basics of how this code works.

```
from the user, get photo locations
create new directory for processed photos
for each photo in location
     if photo has exif data
          convert exif data to GPS degrees
          rename file to GPS data + number
          write renamed file to new directory
     else if photo does not have exif data
          rename photo to "NO GPS DATA" + number
          write renamed file to new directory
```

Not all photos have GPS data. This happens when the phone doesn't have GPS data to give due to remote location on the trail. This happened in perhaps one in 1000 photos. The case of not having exif GPS data was created for error handling. The full source code for this program is available in Appendix 6.5.

3.4 Ethics

The methodology followed traditional ethics for anonymity in surveys. Traditional safeguards for the environment and interviewees were used.

Chapter 4: Results

The 2015 WPI Trail View team successfully documented 64.5 miles of trail and created virtual tours as to show feasibility for future teams.

4.1 Changes in Methods

The original method of photographing the trails was to mount a Ricoh Theta camera on a tripod and take a spherical panorama every 20 feet. The first trail hiked was the Goat Trail, a trail known to be strenuous and rocky. The team began the trail using the agreed upon method. After hiking half a mile, the team decided that this method was ineffective because moving and adjusting the tripod at every new position took a considerable amount of time. In order to document the trails more quickly, the team came up with a new method. In this new method, the tripod was attached to the photographer using their backpack straps so that the camera was more mobile (Figure 3).

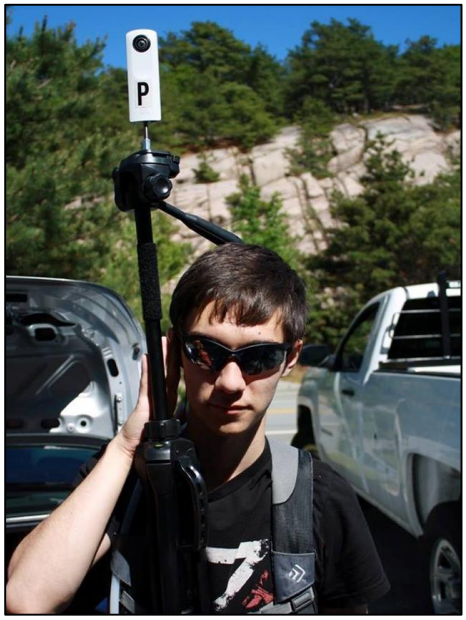

Figure 3: Photographing Method

This method made it so that the tripod didn't need to be readjusted every 20 feet. Instead, the photographer stopped every 20 feet (to ensure that the panorama wouldn't be blurry), took the picture, and moved on.

4.2 Shift in Project Focus

After arriving at Acadia National Park and meeting with park officials, the focus of the project was shifted. Instead of creating a tour for each trail hiked, the park asked the team to focus on hiking as many miles as possible and create only a few tours as a proof of concept. It was decided that future projects would be given the task of assembling tours, while this year was dedicated to photographing as many miles of trail as possible.

4.3 Creating Tours

Though our project shifted focus to taking pictures for future compiled tours, we created some short tours as a proof of concept. This involved taking groups of images from the most scenic trails (Figure 4) and connecting the images through the software Panotour 2.3 (Figure 5).

Figure 4: Unprocessed panorama

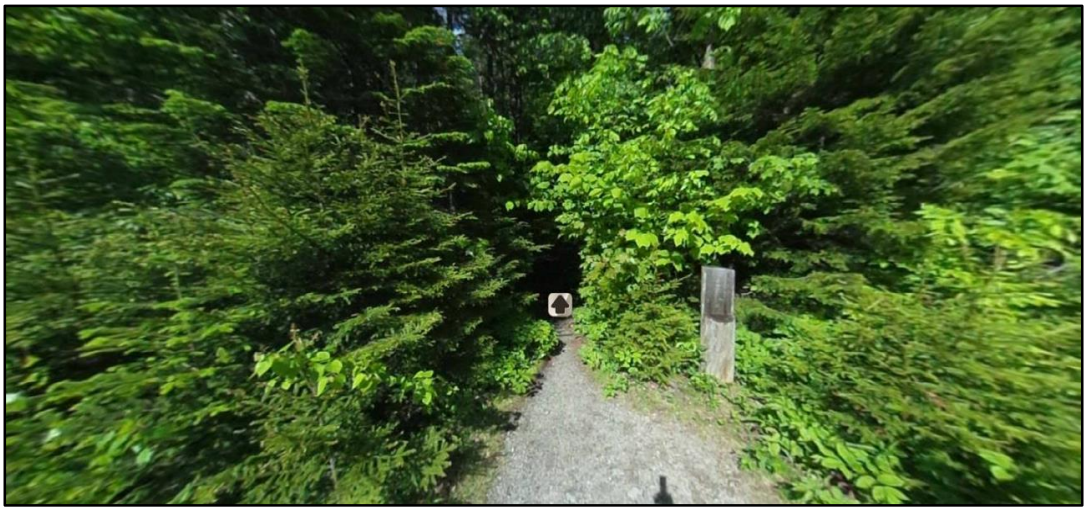

Figure 5: Panorama processed in Panotour 2.3

This gave us a concept of what the finished tours should look like when they are made public online. We recorded ourselves moving through the tour in a video to demonstrate moving forwards, backwards, and looking around a completed tour. The National Park is likely to use their own version of 360-degree tour software, however it will have the same features of Panotour (See 5.3: Alternative Software).

4.4 Trail Selection/Accomplished Mileage

The trails were selected based on their popularity. Park staff were informally surveyed by the team. With the survey information, a list of trails to accomplish was compiled. Once these trails were mapped, the team moved into other trails in the popular areas. A list of all the trails completed and their mileage is included in Appendix 3.4. The total distance documented was 64.5 miles.

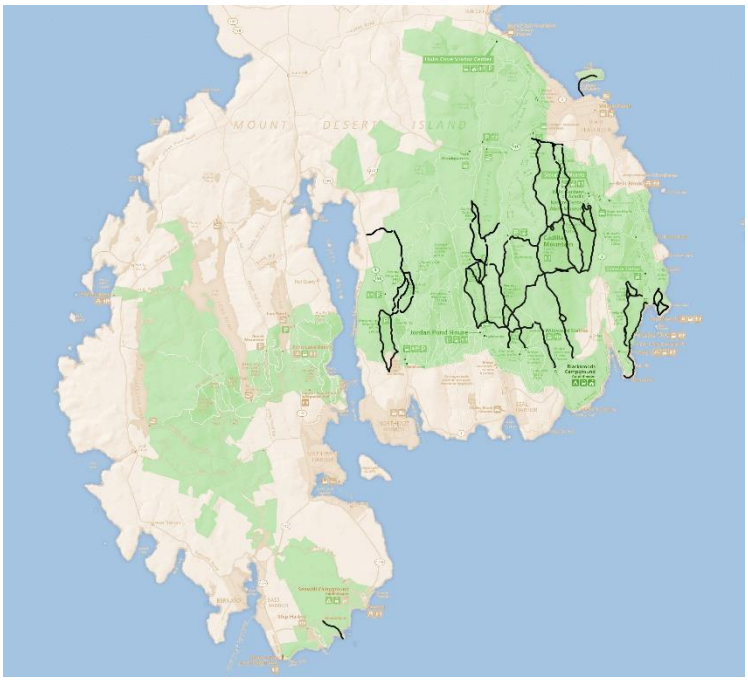

Figure 6: Map of trails completed on Mount Desert Island

Figure 7: Map of trails completed on Schoodic Peninsula

4.5 Formatting Files

Images themselves had to be altered, by name and content. Each image was first re-named with its unique GPS coordinate taken from its metadata (See: Methodology 3.3). Renaming by GPS would make it easier to compile into tours. For privacy reasons, the faces of hikers and tourists could not be shown. Though we took care to wait until people passed or sometimes asked them to turn away, the masses were unavoidable. If faces were taken accidentally, we edited their faces out manually. The process used the photo editor GIMP to select a face in the image and apply a Pixelization filter. Depending on the popularity of the trail, this process was somewhat time-consuming but unavoidable in a popular tourist location.

With thousands of pictures on our storage device, an organizational system was required. Pictures needed organization by trail name, as well as kept chronological through the trail. A day of hiking usually included many different trails and switching of cameras. We used grouping by folders to avoid confusion and disorder. The first grouping was by the date of mapping. The pictures were then separated by the two cameras used on that day. The cameras had to be separated since they had some identically-numbered images. Then inside a camera would be folders named by trail names.

Chapter 5: Recommendations

5.1 Camera and other Hardware Recommendations

A limited factor faced through the project was the battery life of the camera. When taking photographs every 20 feet, the Ricoh Theta would last about two hours. The Ricoh Theta is also unable to charge while in use. These factors caused us to have stop to charge the camera's while on the trails. We recommend investigating these problems to improve mapping efficiency.

The area of fully spherical cameras are still developing. New teams may have different technologies available to them. We highly recommend the use of the newly available "bubl" camera (www.bublcam.com). It has all the features we found would be useful. It has superior resolutions, with more than twice as many pixels. Additionally, it takes spherical stereoscopic pictures. The importance of this is covered in the Virtual Reality section. Another important feature is the ability to charge while in use. Also, we recommend keeping update on the following vendors:

- http://www.ptgrey.com/360-degree-spherical-camera-systems - Spherical Camera Vendor
- http://shop.nodalninja.com/ - Spherical Camera Vendor, provides for Google Street View

5.2 Carriage Road Equipment

The carriage roads are 52 miles of scenic paths. They are traversed on by foot, bicycle and sometimes horseback. This gives a mapping a team the opportunity to use a bicycle. Mapping while on a bicycle could mean a great increase in mapping time efficiency. The Ricoh Theta is best used while still. Pictures taken at even a walking speed are blurry. The team's has two recommendations for teams mapping the carriage roads. Use a bicycle and be able to take pictures while moving.

5.3 Alternative Software

We used the Panotour 2.3 to create the sample tours. We found it to be unsatisfactory. Panotour does not allow the user to zoom in on the tour. This capability would allow users to see interesting points in more detail. Second, Panotour crashes when more than 1,000 photos are uploaded into the tour. This does not allow for tours of the size Trail View requires to be made.

Ultimately the choice of software was left up to the park officials. The tours will most likely be hosted on the Friends of Acadia website. This means the software will need to be approved by the park. We recommend future teams use Panotour for demos, but not a finished product.

5.4 Website Integration and Citizen Science Integration

The Trail View project is growing. Through the use of citizen scientists more information can be added to the trails. This additional information comes without the need for more manpower from the park. We recommend encouraging visitors to take pictures on the trail. These photos can be used to make the Trail View more immersive.

One way to encourage these citizen scientists is to make a Trail View app for phone use. This would allow for visitors of the park to take photographs while hiking and upload them to be viewed alongside the Trail View tours.

5.5 Virtual Reality

5.5.1 What is Virtual Reality?

Virtual Reality (VR) can broadly encompass many things meant to simulate an experience using a computer. Trail View is an example of VR. However, VR is usually meant to mean a stereoscopic head mounted display that can track head movement. This creates a realistic viewing experience. I prominent example of this device is the oculus rift. VR devices are growing and popularity and are believed to become very common in the next few years.

5.5.2 Virtual Reality and the Trail View Team

The park service has shown interest in general VR. We believe that the use of stereoscopic head mounted displays with head tracking could be used very well with spherical panoramas. It would add a layer of realism not present in our 2D spherical panoramas. There are currently devices to create 3D spherical photos. These set ups involve using many cameras in a single mount. The details of them are beyond the scope of this paper. The following are links for interested readers:

- http://krpano.com/ - software for viewing 3D spherical photos
- http://www.airpano.com/ - Arial spherical 3D photos

Chapter 6: Conclusions

Overall, the team met the project goals. The project successfully addressed three important points in “A Call to Action”: “Parks for People” (point 5), “Next Generation Stewards” (point 7), and “Go Digital” (point 17). To address these three points, 64.5 miles of trail were mapped in Acadia National Park. Some of these trails were turned into virtual tours using Panotour 2.3. These virtual tours demonstrate the feasibility of making the images accessible to the public by putting the tours online.

The team accomplished this by using the Ricoh Theta camera to take spherical panoramas while hiking the trails. Each panorama was tagged with GPS data to indicate its location. These panoramas were given to Acadia National Park to be integrated into the Friends of Acadia website in the future as a virtual map of the trails.

The team’s recommendation for future years would be to use virtual reality technology to make the tours more interactive for park visitors or to provide views which would otherwise be inaccessible to the public.

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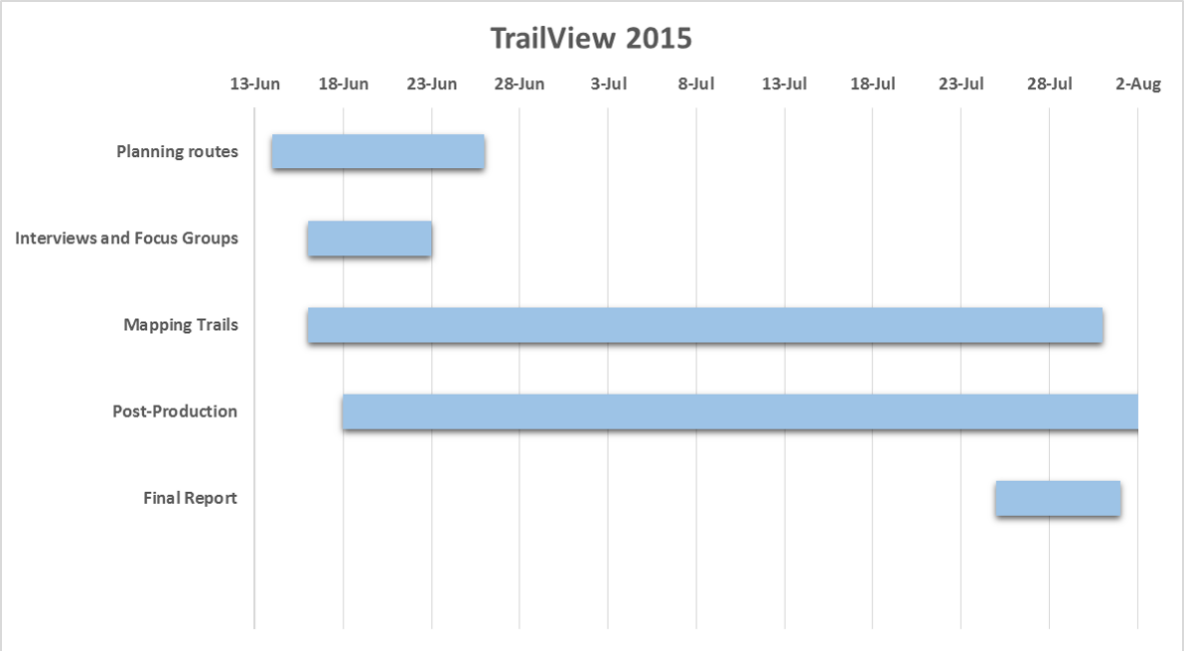
Appendicies

7.1 Gantt Chart - Proposed Schedule



7.2 Trails/Areas Selected

1. Norumbega Mountain Loop
2. Penobscot Mountain Loop
3. Sargent Mountain Loop
4. Gorham Mountain Loop
5. Cadillac Mountain South Ridge
6. Parkman Mountain Loop

7.3 Trails Completed

Trail Name	Miles
Beehive Trail	0.6
Bowl Trail	1.1
Gorham Mountain Trail	1.6
Ocean Path	2.1
Gorge Path	2.0
Cadillac South Ridge Trail	0.5
Cadillac North Ridge Trail	2.2
Kebo Brook Trail	0.7
Hemlock Trail	0.2
Kebo Mountain Trail	0.9
Dorr North Ridge Trail	0.8
Schiff Path	1.2
Dorr South Ridge Trail	1.4
A. Murray Young Trail	1.2
Canon Brook Trail	1.1
Kane Path	0.8
Kurt Diederich’s Climb	0.4
Ladder Trail	0.4
Hunters Brook Trail	2.1
Triad Trail	0.8
Bubble and Jordan Ponds Path	0.7
Pemetic East Cliff Trail	0.3
Pemetic South Ridge Trail	0.8

Triad Pass Trail	0.5
Jordan Pond Path	3.4
Bubbles Divide	0.4
Bubbles Trail	0.6
Jordan Pond Carry	0.4
Goat Trail	0.6
Norumbega Mountain Trail	2.2
Hadlock Ponds Trail	0.6
Norumbega Connector	1.0
Wonderland Trail	0.7
Jordan Pond House Path	0.7
Spring Trail	0.3
Penobscot Mountain Trail	1.4
Asticou & Jordan Pond Path	1.2
Pemetic Northwest Trail	0.5
Pemetic North Ridge Trail	2.0
Pemetic South Ridge Trail	0.7
Bubble and Jordan Ponds	1.4
Cadillac South Ridge Trail	2.3
Eagles Crag Loop Trail	0.3
Bubbles Trail	1.7
Eagle Lake Trail	1.8
Jordan Pond Carry	0.6
Parkman Mountain Trail	2.2
Giant Slide Trail	1.9
Maple Spring	0.6

Hadlock Brook Trail	0.5
Bald Peak Trail	0.9
Great Head Trail	2.1
East Trail	0.4
Anvil Trail	0.8
Schoodic Head Trail	0.7
Alder Trail	0.6
Buck Cove Mountain Trail	3.2
Lower Harbor Trail	1.5
Total	**64.6**

7.4 Source Code

Please note this code is open source and can be forked at: https://github.com/DeadSocks/Photo-Geotagging

```
# -*- coding: utf-8 -*-
from PIL import Image
from PIL.ExifTags import TAGS, GPSTAGS
import os
import time
from shutil import copyfile

def get_exif_data(image):
      exif_data = {}
      info = image._getexif()
      if info:
            for tag, value in info.items():
                  decoded = TAGS.get(tag, tag)
                  if decoded == "GPSInfo":
                        gps_data = {}
                        for t in value:
                              sub_decoded = GPSTAGS.get(t, t)
                              gps_data[sub_decoded] = value[t]

                        exif_data[decoded] = gps_data
                  else:
                        exif_data[decoded] = value
      return exif_data
```

```
def _get_if_exist(data, key):
      if key in data:
            return data[key]
      return None

def _convert_to_degress(value):
      d0 = value[0][0]
      d1 = value[0][1]
      d = float(d0) / float(d1)

      m0 = value[1][0]
      m1 = value[1][1]
      m = float(m0) / float(m1)

      s0 = value[2][0]
      s1 = value[2][1]
      s = float(s0) / float(s1)

      return d + (m / 60.0) + (s / 3600.0)

def get_lat_lon(exif_data):
      lat = None
      lon = None
      if "GPSInfo" in exif_data:
            gps_info = exif_data["GPSInfo"]

            gps_latitude = _get_if_exist(gps_info, "GPSLatitude")
            gps_latitude_ref = _get_if_exist(gps_info,
'GPSLatitudeRef')
            gps_longitude = _get_if_exist(gps_info, 'GPSLongitude')
            gps_longitude_ref = _get_if_exist(gps_info,
'GPSLongitudeRef')

            if gps_latitude and gps_latitude_ref and gps_longitude and
gps_longitude_ref:
                  lat = _convert_to_degress(gps_latitude)
                  if gps_latitude_ref != "N":
                        lat = 0 - lat

                  lon = _convert_to_degress(gps_longitude)
                  if gps_longitude_ref != "E":
                        lon = 0 - lon
      #else: # Depriciated, but keep becuase annoying to rewrite if
needed later.
            #lat = [((99, 9), (99, 9), (9999, 999))]
            #lon = [((99, 9), (99, 9), (9999, 999))]
            #gps_longitude = [((99, 9), (99, 9), (9999, 999))]
            #gps_latitude = [((99, 9), (99, 9), (9999, 999))]
      return lat, lon, gps_longitude, gps_latitude

def generateName(lat, lon):#This generates the string that is the
```

```
geotag from the exif data from the file.
     return (str(lat[0][0]) + "." + str(lat[1][0]) + "." +
str(lat[2][0])[0:2]+ "." + str(lat[2][0])[2:4] + "N" + "-" +
str(lon[0][0]) + "." + str(lon[1][0]) + "." + str(lon[2][0])[0:2] +
"." + str(lon[2][0])[2:4]  + "W.JPG")



def rename(name, indir, outdir):

     global num_taggless
     num_taggless = 0
     img = Image.open(indir + "/" + name)
     imgIn = open(indir + "/" +  name, 'r')
     data = get_exif_data(img)

     lon = get_lat_lon(data)[2]
     lat = get_lat_lon(data)[3]
     #print lon
     #print lat

     if lon != None:
          nameOfProcFile = generateName(lat, lon)
          #nameOfProcFile = str(lat[0][0]) + "." + str(lat[1][0]) +
"." + str(lat[2][0])[0:2]+ "." + str(lat[2][0])[2:4] + "N" + "-" +
str(lon[0][0]) + "." + str(lon[1][0]) + "." + str(lon[2][0])[0:2] +
"." + str(lon[2][0])[2:4]  + "W.JPG"

     else:
          num_taggless = num_taggless + 1
          nameOfProcFile = "NoGPS.JPG"

     copyfile(indir + "/" + name, outdir + "/" + name[0:8] + " "
+nameOfProcFile)
     imgIn.close()

indir = str(input("What's the name of the directory that your
unprocessed pictures are in?"))
outdir = "Renamed " + indir
if not os.path.exists(outdir): os.makedirs(outdir)
files = os.listdir(indir)
for elt in files:
     print str(elt)
     rename(str(elt), indir, outdir)
if num_taggless == 0:
     print "All of these photos have GPS data."
elif num_taggless == 1:
     print "One of the photos doesn't have GPS data."
else:
     print num_taggless + "photos dont have GPS data."
```