

Requesting Images of Pittsburgh from The International Space Station:A Skyglow Research Project

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Project InformationIntroduction

This Research Project forms a part of Carnegie Mellon University's Collection and Analysis of Skyglow Data class. The class aims to introduce students to the concept of light pollution and the current threat it poses to our society. From there, these students go on to contribute to their own research projects in order to continue raising much-needed awareness for the dangers surrounding light pollution and support existing researchers' work.

The objective of this project is to write a proposal to the International Space Station's Remote Sensing Unit in order for them to take high-resolution overhead photographs of Pittsburgh at night, thereby enabling us to highlight the extent of its light pollution.

Background

The International Space Station (ISS) is a space station in low-orbit of the Earth. It serves a number of purposes, including being used as a research laboratory for astronomy and earth sciences. The ISS also serves as a temporary home for the on-board crew conducting the various experiments. As part of their work, the astronauts lead the Crew Earth Observations Project, taking photographs of numerous locations to support the scientific education of people around the world.

Why Light Pollution?

These photographs will be essential to supporting Carnegie Mellon University's ongoing research to help combat light pollution, which is a rapidly spreading problem whereby the increased reliance on artificial light leads to a number of detrimental impacts. In many cases, artificial light sources, such as streetlights, are poorly designed in that they illuminate far more than the area directly below them. This leads to impacts such as greatly reducing the visibility of stars in the night sky, which in turn reduces the ability of astronomers to study their targets effectively. These impacts also extend far beyond inhibiting the work of astronomers; they affect a vast range of areas, from threatening the biodiversity of ecosystems¹ to increasing the risk of women contracting breast cancer².

In the wider community, it is essential to realise the dangers of light pollution and how it is affecting so many facets of our lives. Without this awareness, both governments and the general public will continue to choose these cheaper alternatives without first considering the negative impacts they cause to their surroundings.

Why the ISS?

We believe that the Crew Earth Observation scheme is the perfect solution to our needs – we need high-resolution overhead pictures of Pittsburgh at night in order to support our work raising awareness about light pollution in the city. Different sources of light illuminate their surroundings in subtly different ways, such as when comparing High Pressure Sodium (HPS) bulbs against LEDs. However, despite the seemingly minor differences, they can have profoundly different impacts. We therefore need images with a high-enough resolution to capture these visible differences, as this will be critical in showing how drastically light

pollution has worsened in Pittsburgh in recent years. Given that the ISS themselves admit that ‘*they provide greater spatial resolution than any other orbital source of city light data,*’³ they are clearly the best suited source for our needs.

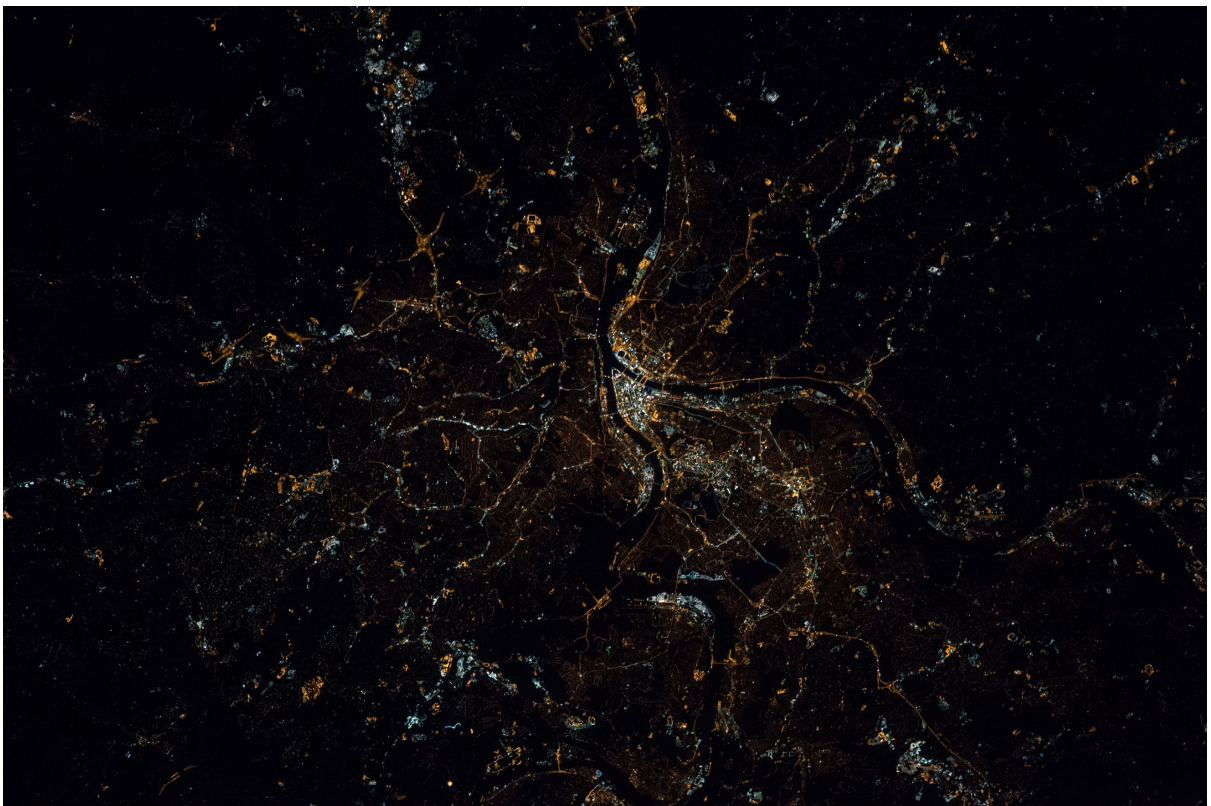
The ISS observations’ value to us only increases further when we consider how there is no comparable resource available. For example, the Visible Infrared Imaging Radiometer Suite’s (VIIRS) low resolution makes it impossible to distinguish a city’s features⁴. On the other hand, although the Luojia 1-01 Satellite is capable of taking appropriate images, it does not have a system in place to allow us to request new data. With a lack of other viable sources, we would have no way to obtain suitable data to support our work.

Is this kind of data already available?

I recently coordinated with my fellow classmate/researcher Julia Lu, who is working on a project to identify and collate all existing photographs of Pittsburgh at night from NASA’s astronaut archives. Unfortunately, she has only been able to identify *two* images in the past 8 years. This information was particularly pertinent to me as it reveals the severe lack of images of Pittsburgh at night, further necessitating the need for new, up-to-date images.



Pittsburgh from above in 2012⁵



Pittsburgh from above in 2016⁶

Despite there only being a gap of four years between these two images, we can clearly see that there has been a significant change in that time. Traditional HPS bulbs have been replaced in favor of newer LED technology, and this is shown by the dramatic increase in white light visible in the 2016 image. The City of Pittsburgh has announced plans to continue on this campaign of moving towards all-LED lights, a worrying sign given that light pollution levels will have already increased as a result of the changes so far. It is therefore critical to have updated images as we can clearly see how much change can take place in a relatively short period of time.

How will these images be used?

These images would be an invaluable resource to help to reduce light pollution levels in Pittsburgh. As mentioned previously, the impacts of light pollution are both harmful and widespread, and unfortunately Pittsburgh is by no means immune to them. In their attempts to choose more affordable lighting instruments, the Mayor of Pittsburgh embarked on a massive campaign⁷ to overhaul all 40000 of its streetlights with LED replacements. This decision unfortunately overlooked the massive potential increase it could cause to light pollution, setting Pittsburgh on a worrying path for future years.

Professors Diane Turnshek and Steven Quick have already liaised with the office of the City of Pittsburgh, who have agreed to act to reduce light pollution. However, this relies on us being able to provide evidence revealing the extent of Pittsburgh's light pollution levels.

Images from the CEO would give us a clear view of the current situation; having already studied existing images from the CEO's 2012 and 2016 archives, we observed a worrying increase in pollution levels, and we believe this upward trend has only increased further in

recent years. There is therefore an urgent need for these images in order to help drive change as soon as possible.

References:

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Internship Role:

My role has consisted of directly working with Professor Turnshek to deliver two proposals to the International Space Station's Remote Sensing Lab. Our main goal is having an application successfully accepted by their Crew Earth Observations scheme, whereby the astronauts will manually take photographs of Pittsburgh using hand-held cameras. In addition to this however, we are also exploring the possibility of filing a separate application to another ISS division in order to obtain images through a different set of instruments.

I first had to create a framework of key points to structure my proposal around. These key points sought to cover why the ISS's images would be so necessary to us, as they explained the significance of light pollution as well as how these images would be used to help combat Pittsburgh's growing pollution levels. In order to do this, I had to conduct research into some of the most significant impacts that light pollution can cause. I had initially aimed to find studies detailing how people had been affected by some of these impacts within Pittsburgh specifically, however I was unable to find sufficient information. Despite this, I was able to find evidence for Pittsburgh's worrying increase in light pollution levels, as evidenced by the City's plan to introduce widespread changes to increase the frequency of LED lights.

Experience Description

For this project, I have developed my proposal following the guidance of Professor Turnshek. She advised me how to construct my proposal, as well as some of the key targets I needed to hit, such as the need to explain to the ISS that no other options are viable for us, and so their assistance would be even more vital. I have also enjoyed being able to have the freedom to write the proposal myself, as this gave me the license to focus on areas that I felt were important. For example, when explaining the significance of light pollution's impacts, I felt that it was imperative to emphasize how it affects not only wildlife but can also have dire effects on humans' health. I was also hugely excited by the thought of contributing to a project that could benefit the entire cityscape. As someone who has always had a strong interest in urban economics and the way our cities are constructed, it has been a hugely fulfilling experience to help this project.

Knowledge Gained

I will leave this class with a wealth of newly-acquired information. Back in high school, I was torn between choosing studying in the US and Cambridge's 'Land Economy' degree, a hybrid course with a heavy emphasis on Environmental Economics and Law, before ultimately choosing the US. I now feel vindicated by this decision as this course has given me the opportunity to have the best of both worlds and experience both my Business degree and learn about ways to contribute to the improvement of cities! I have been particularly intrigued by topics such as the importance of streetlight design, a theme that I think has been reflected in several of my assignments. I must admit that I had never encountered light pollution before this summer, however I now feel that I have a much better understanding of its impacts. I have greatly appreciated how eye-opening this class has been, and I can only express my thanks to Professors Quick and Turnshek for running this fantastic course.

Timeline:

Assignment	Time Spent/Hours
Lectures	18
ALAN Conference	8
Interview	4
Scientific Accommodation:	6
Research Proposal	4
Research Updates	4
Research Storytelling	2
Proposal: 07/13-07/19	16
Tasks:	
- Introductory reading on ISS National Lab	

<ul style="list-style-type: none"> - Reading on ISS' Remote Sensing Unit - Explored other databases for overhead pictures of Pittsburgh e.g. EU Space Imaging (to no avail, as none of the images were taken at night) 	
<p>Proposal: 07/20-07/26</p> <p>Tasks:</p> <ul style="list-style-type: none"> - Researched potential alternatives sources of data to ISS, eg. VIIRS, LuoJia, European Space Agency - Compiled list of points as to why these alternatives are unsuitable for our needs - Created contrasting list of points detailing why the ISS's instruments are ideal for us 	<p>12</p>
<p>Proposal: 07/27-08/02</p> <ul style="list-style-type: none"> - Compiled research on light pollution - Searched for information regarding the extent of pollution in Pittsburgh - Comprised information on Pittsburgh's planned development projects (e.g. LED light replacements) - Researched potential liability issues of opting for dimmable streetlights (e.g. could City planners be sued for a lack of 'safe' lighting?) 	<p>13</p>
<p>Proposal: 08/03-08/09</p> <p>Tasks:</p> <ul style="list-style-type: none"> - Composed first draft of CEO Proposal 	<p>17</p>

<ul style="list-style-type: none">- Researched EU Space Imaging's GeoEye-1 and Worldview-1 Satellites- Researched process of obtaining new data from the EU Space Imaging team	
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*n.b Work on Research Project began during week beginning 07/13/2020