Enhancing Utility Pole Monitoring Through Automated Detection with Google Street View

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Abstract

In the face of climate change, the accurate and consistent monitoring of utility poles is becoming more important for preventing wildfires and ensuring community safety. Traditional methods for maintaining utility pole databases are fraught with challenges, including data incompleteness and the labor-intensive nature of manual updates. Previous approaches have struggled to efficiently update and verify the accuracy of these databases, leaving a significant gap in utility risk management practices. Our project addresses this gap by developing an automated tool that leverages Google Street View images and advanced computer vision techniques to identify and analyze utility poles. By inputting geographical coordinates, our system captures images along specified roads, detecting each pole's material type. This automation significantly reduces human error and labor, offering a scalable solution to improve the accuracy and completeness of utility pole records. Our method introduces a novel approach to utility infrastructure monitoring, promising enhancements in reliability, safety, and responsiveness to environmental risks.

Website: https://jcheung4.github.io/DSC180B-Website/
Code: https://github.com/jcheung4/DSC180B

1 Introduction

As climate change has increased the chances of wildfires over the recent years, utility risk management has become an integral aspect of community safety. Many of the current databases keeping track of utility poles are often incomplete, with relevant data missing. Our project proposes an automated solution that uses Google Street View and computer vision to change the way utility poles are monitored. By automating the detection and analysis of utility poles, our tool aims to significantly enhance the accuracy and efficiency of utility pole databases, thereby contributing to the prevention of wildfires and the enhancement of community safety.

The challenge of maintaining accurate and comprehensive utility pole records is not new. Previous efforts have primarily relied on manual inspections and record-keeping, which are both time-consuming and prone to human error. These approaches also face challenges related to cost, scalability, and the resolution of captured images. Recent advancements in technology have led to the exploration of automated systems for infrastructure monitoring, utilizing image capture technology. Our project builds upon these foundations by leveraging the accessibility of Google Street View imagery, coupled with computer vision to offer a new and scalable solution for utility pole monitoring.

Our project utilizes a dataset of images from Google Street View, offering a comprehensive coverage of urban and rural roadways where utility poles are commonly located. The data's broad geographic scope makes it an important resource and step for developing a scalable and efficient tool for utility pole monitoring with the potential for widespread application across different scenarios.

2 Methods

Our project aims to automate the identification of utility poles using Google Street View images and computer vision. This process involved several key steps: data collection through the Google Street View API, image processing and pole detection using DETR (DEtection TRansformer) object detection models, and data validation against a utility pole database with our own. This section describes the methodology we employed across these stages, ensuring that our approach is able to be replicated and transparent.

2.1 Data Collection

We started our project by collecting images of utility poles from Google Street View. To achieve this, we created a python script and utilized the Google Street View API to capture images of different utility poles from different angles and field of views, collecting over 800 images in the process. This method ensured comprehensive coverage and diversity in the images collected.

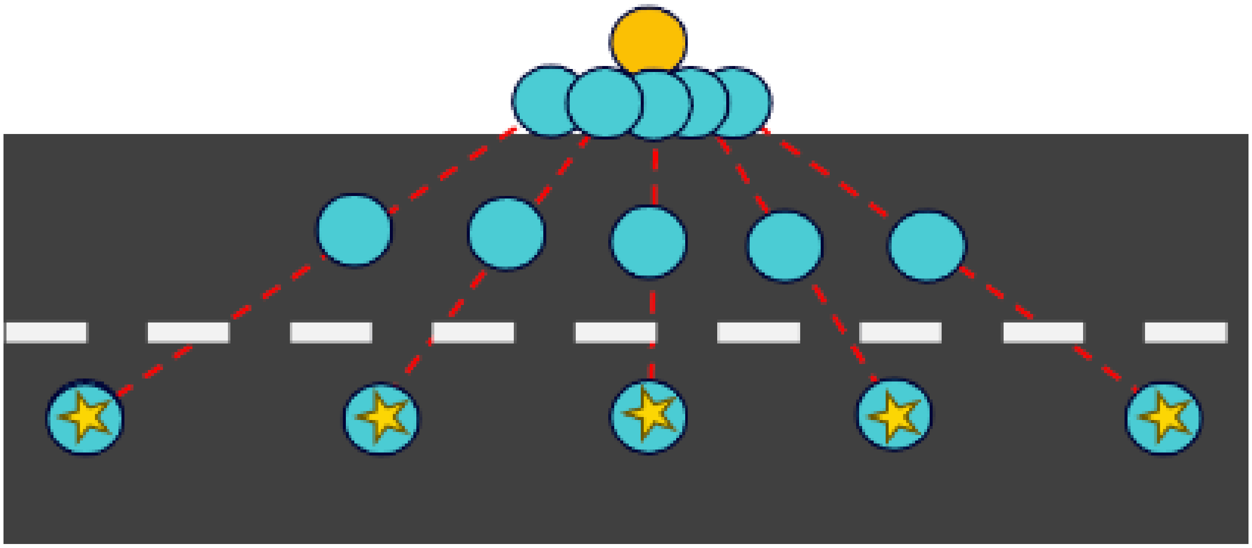


Figure 1: How a utility pole (yellow circle) would be captured from different angles and field of views (blue circles)

2.2 Image Processing and Pole Detection

We employed a DETR (DEtection TRansformer) object detection model to specifically identify utility poles from the Street View images. The DETR model, known for its efficiency in processing images and detecting objects within them, was adapted to recognize the material quality of the utility poles.

We fine-tuned the DETR model using a subset of different manually annotated images, which also included different angles and field of views of utility poles. This training process involved adjusting the model's parameters to improve its accuracy in detecting poles from various angles.

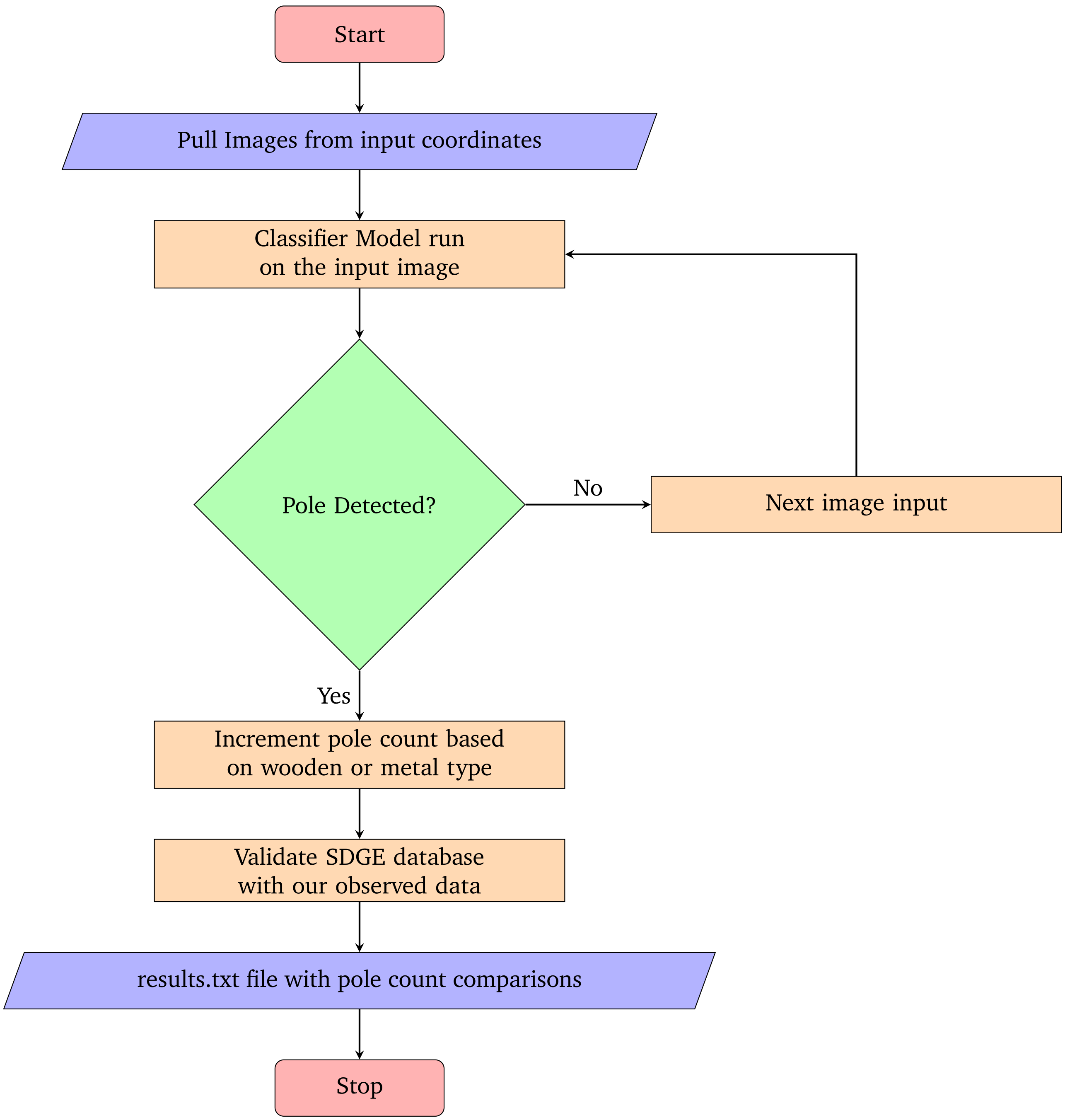
To demonstrate our project's practical application, we developed a script that navigates through a predefined street segment using starting and ending coordinates. As the script progresses along the street, it employs our model to identify and classify any wooden or metal utility poles encountered, showcasing the model's real-world utility and effectiveness.

2.3 Data Validation Against a Utility Pole Database

The final step in our methodology involved recording the detected poles in our own database and validating it against an existing utility pole database. This process was crucial for assessing the completeness and accuracy of the database and identifying any discrepancies.

To setup our database, which was a replica of SDG&E's database, we utilized Docker for the initial setup. This allows us to create a docker container using a PostgreSQL image and allows us to create, read, update, and delete tables when needed. Based on the initial coordinates that are provided, we can query the database using a distance calculation to obtain the count of poles between the initial coordinates. For our own database, we can add the coordinates of the pole whenever a model detects it.

The information from the detected poles from out dataset is then compared with the database of SDG&E's to identify missing poles, inaccuracies in material classification, or any other discrepancies. This comparison allowed us to assess the effectiveness of our detection model and the quality of the existing database records. Although we do not have access to SDG&E's full database of utility poles, we were given permission and access to a sample set of its database to use.



3 Results

3.1 Our Database after Workflow

Table 1: Rows from our database with input coordinate pairs (32.7077,-117.0841) and (32.7077,-117.0830)

Latitude	Longitude	Classification
32.7077092	-117.084070	Wooden
32.7077091	-117.0836202	Wooden
32.7077089	-117.083220	Wooden

3.2 SDG&E's Actual Database

Table 2: Rows from SDG&E's Database with input coordinate pairs (32.7077,-117.0841) and (32.7077,-117.0830)

Latitude	Longitude	Type
32.7077154	-117.084068	Wooden
32.7077132	-117.0836056	Wooden
32.70771	--117.0832791	Wooden

Figure 2: Poles detected using model from images fetched using Google Street View API

Figure 3: Demo of model being used in traversal and compared with a database

4 Discussion

The results presented showcases the capability of our automated system to detect and classify utility poles using Google Street View images. By comparing the classifications in our database with those in SDG&E's actual sample database, we observe a good amount of consistency, suggesting that our model performs well in identifying wooden and metal utility poles in the given geographic area.

While previous studies may have focused on other aspects of utility pole monitoring, our approach leverages recent advancements in computer vision, providing a new perspective.

It's crucial to acknowledge the limitations of our study. One significant constraint is the reliance on Google Street View images, which are not updated in real-time and might not reflect the current state of the utility poles. Our model's performance is directly tied to the quality and resolution of the images, and it may struggle with images of poor quality or with obstructed views of the poles. Additionally, the current traversing algorithm to collect street images has the potential of under counting the poles.

Looking ahead, there are several avenues for future work to build upon our project. Enhancements in the model's accuracy, especially in differentiating between more varied types of utility poles and in more challenging visibility conditions, could be a key area of focus. Identifying more key features of utility poles rather than just its material quality could provide further usage. Further, integrating real-time data sources or employing drones for image capture could offer more up-to-date and comprehensive data for analysis.

5 Conclusion

Our project demonstrates the potential of Google Street View imagery with computer vision to enhance the monitoring and management of utility poles. By automating the detection and analysis of utility poles, we can increase the efficiency and scalability of utility infrastructure monitoring. This is crucial for preventing wildfires and ensuring community safety in the face of climate change.

Our methodology, employing the DETR object detection model fine-tuned on utility pole images, can be effective in identifying utility poles and their material quality. This approach not only reduced the dependency on manual, labor-intensive methods but also improved the precision and comprehensiveness of utility pole databases.

The validation of our model's detections on our own database against an existing database highlights the system's reliability and the potential for enhancing data quality in utility management. The discrepancies identified through this comparison provide valuable insights into the areas where the current databases may lack accuracy or completeness.

Future work could focus on further refining the detection algorithms, identifying more features of a utility pole, expanding the dataset to include more diverse environmental conditions, and exploring real-time monitoring applications. Additionally, integrating this technology with other data sources and predictive analytics could offer even more solutions for infrastructure management and disaster prevention.

Our project represents a step forward in the application of computer vision for infrastructure monitoring. It showcases the concept, feasibility, and benefits of leveraging existing technologies and datasets in new, innovative ways to address critical challenges in utility management and environmental safety.