**Depth-Based Simulation and Low-Light Imaging of Abandoned Mines in AL**

Cameron Wiebe  
Samford University  
800 Lakeshore Dr  
Birmingham, AL 35229  
+1 813 382 4393  
<mailto:cwiebe@samford.edu>

Brian Toone  
Samford University  
800 Lakeshore Dr  
Birmingham, AL 35229  
+1 205 726 2960  
[brtoone@samford.edu](mailto:brtoone@samford.edu)

**Abstract**

This project employs the ML-Depth Pro tool to transform a catalog of abandoned mine entrance images in Alabama, with a primary focus on Red Mountain Park, into depth-based LiDAR data. Phase 1 focuses on ensuring that photos of mine entrances from the existing catalog are compatible with the ML-Depth Pro tool by evaluating the tool's ability to process flat images (JPGs) into usable 3D depth maps. This research is critical because these mines are collapsing and becoming increasingly dangerous to explore. Preservation programs initiated by the city and state have added barred entrances to prevent access for safety reasons. As a result, only entrances that have been excavated by the city are accessible for documentation. These conditions highlight the need for safer, virtual alternatives for studying and preserving these historically significant sites. This phase will test the feasibility of converting these standard images into accurate depth-based LiDAR data. Phase 2 shifts the focus to testing the tool's performance with low-light imaging by taking new photographs in mines and other dark environments. This phase will assess whether the system can accurately generate depth data in environments without the need for external lighting. While the project's primary focus is on mines, the methodology developed could be extended to other similar environments, such as caves, hiking trails, and infrastructure, offering broader applications in collecting image based spatial data. By focusing on publicly accessible entrances and existing image data, the project eliminates the need for permissions while providing a scalable framework for abandoned mine preservation.

**1. Introduction**

Abandoned mines are a significant part of industrial history, but many remain inaccessible due to safety risks and regulatory restrictions. Traditional LiDAR scanning methods, while effective, often require physical access to these sites, which can be both challenging and resource-intensive. This project aims to overcome these limitations by using the open-source ML-Depth Pro tool to create 3D depth models from flat images. The dual-phase approach—first evaluating depth map generation and then developing low-light imaging—ensures both versatility and scalability for research and preservation efforts.

**2. Background**

Alabama’s abandoned mines, particularly those in Red Mountain Park, are rich in historical significance. This project will focus primarily on the abandoned iron ore mines in Red Mountain Park and Ruffner Mountain, two historically significant sites in Alabama. Both locations feature numerous mine entrances that played a pivotal role in Birmingham’s industrial growth. These sites often include barred portals or sealed entrances, making traditional LiDAR scanning impractical. The ML-Depth Pro tool, developed by contributors in the open-source community, provides a promising alternative by using advanced machine learning to estimate depth from standard images. This approach enables researchers to generate depth data without physical access to the interiors of mines, reducing both logistical and regulatory barriers.

The project will involve taking photographs of mine entrances, focusing on capturing the complexity of scenes such as barred portals, overgrown vegetation, and environmental obstructions. These images will provide a diverse dataset to test the capabilities of ML-Depth Pro in generating depth data from intricate and challenging visuals.

**3. Methodology**

**3.1 Phase 1: Depth Map Generation**

1. **Dataset Preparation**: A catalog of mine entrance images will be compiled, capturing diverse and challenging conditions to ensure compatibility with ML-Depth Pro.
2. **Depth Map Processing**: Using ML-Depth Pro, flat JPG images, including those with intricate details like metal bars, concrete structures, and overgrown vines, will be converted into depth maps. The tool's ability to handle these complexities will be a critical aspect of evaluation. The quality of these maps will be evaluated based on resolution, accuracy, and usability for 3D modeling.
3. **Validation**: Depth maps will be compared against existing LiDAR data (if available) or assessed qualitatively for realistic depth representation.

**3.2 Phase 2: Low-Light Imaging**

1. **Dataset Augmentation**: Low-light images will be captured directly from mine entrances to create a dataset reflective of real-world conditions. This approach eliminates the need for artificial simulation and ensures accurate evaluation of ML-Depth Pro's capabilities.
2. **Low-Light Model Training**: ML-Depth Pro’s capabilities in low-light scenarios will be tested. If necessary, additional training data or preprocessing techniques will be implemented to improve performance.
3. **Evaluation**: Results will be analyzed to determine whether ML-Depth Pro can effectively generate depth data under low-light conditions.

**3.3 Tools and Platforms**

* **Software**: ML-Depth Pro, Unreal Engine 5
* **Hardware**: MacBook Pro with Apple Silicon (or equivalent), external storage for dataset management

**4. Expected Outcome**

Phase 1 is expected to demonstrate the feasibility of converting flat images into depth-based LiDAR data, enabling the creation of 3D models from existing datasets. Phase 2 will evaluate whether this methodology can be extended to low-light scenarios, potentially unlocking new applications in mine interiors or poorly lit environments. A successful project will provide:

* High-quality depth maps from 2D images
* Prototype low-light depth mapping capabilities
* A scalable framework for abandoned site documentation and preservation

**5. Summary**

This project bridges the gap between accessibility and advanced documentation techniques for abandoned mine preservation. By utilizing the open-source ML-Depth Pro tool, it explores innovative ways to generate depth data from flat images, offering a practical alternative to traditional LiDAR scanning. If the fundamentals of this research prove successful, the methodology could potentially be adapted for deeper explorations into mine interiors, enabling comprehensive 3D mapping and simulation of entire underground networks. With its focus on existing datasets and minimal site permissions, the project ensures scalability and adaptability for future research and applications.

**6. References**

1. Apple ML-Depth Pro. "Depth Estimation Framework." Available: https://github.com/apple/ml-depth-pro
2. Ruffner Mountain. "Mining History." Available: https://ruffnermountain.org/mining-history
3. Red Mountain Park. "About." Available: https://redmountainpark.org/about/