

IMPROVING MINERS' SAFETY TRAINING BY UTILIZING 360 DEGREES CONTENT

Lazar Žujović^{1a}, Aleksandar Cvjetić^{1b}, Miljan Gomilanović^{2a}, Nikola Stanić³,
Aleksandar Doderović^{2b}, Dejan Bugarin^{2c}

¹ Faculty of Mining and Geology, Đušina 1, Belgrade, 11000 Belgrade, Serbia

² Mining and Metallurgy Institute Bor, Alberta Ajnštajna 1, 19210 Bor, Serbia

³ RB Kolubara, EPS, Svetog Save 1, 11550 Lazarevac, Serbia

^{1a} zujovic.lazar@gmail.com, <https://orcid.org/0000-0002-6197-1041>;

^{1b} aleksandar.cvjetic@rgf.bg.ac.rs, <https://orcid.org/0000-0002-2404-4679>;

^{2a} miljan.gomilanovic@irmbor.co.rs, <https://orcid.org/0000-0002-1209-7423>;

³ nikola.stanic@eps.rs, <https://orcid.org/0000-0002-6620-8563>;

^{2b} aleksandar.doderovic@irmbor.co.rs, <https://orcid.org/0000-0003-3665-6784>;

^{2c} dejan.bugarin@irmbor.co.rs, <https://orcid.org/0000-0002-9103-4614>

Abstract

Technological advancements have led to the emergence of various devices that can enhance employee safety in the mining industry. Even though there is no true substitute for hands-on training, certain devices can improve training, thereby making the working process safer. One such device is the 360-degree camera, which can be used to create 360-degree content, including both videos and images.

Keywords: mining, 360 degrees content, mine training, mine safety

1. INTRODUCTION

Mine safety and health are of utmost importance for the entire mining operation, both surface and underground. In this regard, the enhancement of mine training can also have a positive impact on the mining work process. Today, there are numerous devices being utilized to improve miners' safety. For example, various dust sensors, proximity warning systems, dust monitoring devices, etc. Additionally, 360-degree cameras can be employed to create content that can assist in miners' training.

One of the cameras that will be discussed in this paper, in the context of safety training, is the GoPro MAX, the successor to the GoPro Fusion, which was the first 360-degree camera from GoPro. GoPro max is shown in Figure 1.



Figure 1. GoPro MAX [1]

In addition, various mounts and tripods should be used to achieve better images and videos. Examples of different mounts are present in Figure 2.



Figure 2. Various mounts and tripods [personal archive]

2. BASIC CHARACTERISTICS

MAX is a versatile 360-degree camera that represents a significant advancement in the action camera market [1]. The camera offers a unique combination of 360-degree video capture, standard wide-angle shooting, and innovative editing features. Beyond its traditional applications in sports and recreation, this camera holds considerable potential for enhancing safety and training protocols. In industries such as mining, construction, or in emergency response, this camera can show potential contributions to workplace safety and training.

The GoPro MAX is built with the ruggedness typical of GoPro products, making it an ideal choice for use in harsh and demanding environments. Waterproof up to 5 meters without requiring additional housing, the camera is well-suited to environments where exposure to water, dust, or dirt is common. Its dual-lens system enables comprehensive 360-degree capture, while its compact and durable construction ensures it can withstand the rigors of field use. The addition of a touchscreen interface is particularly useful in training contexts, allowing for easy adjustments and real-time review of footage, which is critical for on-the-spot training and assessments.

The camera is capable of recording 360-degree video at 5.6K resolution at 30 frames per second (fps), and delivers high-definition, immersive footage. Although this resolution is lower than that of some other cameras, the GoPro MAX's ability to reframe 360-degree footage during post-production provides a significant advantage [2]. This feature is particularly valuable for safety and training purposes, as it allows trainers and supervisors to analyze multiple angles of an incident or training scenario, helping to identify hazards or errors that might not be apparent from a single perspective. It captures 16.6-megapixel 360-degree images. The seamless stitching of 360-degree photos ensures a comprehensive and detailed view of any environment, which is particularly important for documenting complex work sites or training environments. However, the camera's performance in low-light conditions is less impressive, with increased noise and grain in darker settings, which may be a limitation in certain industrial applications.

3. APPLICATIONS FOR SAFETY TRAINING

The GoPro MAX offers considerable potential for enhancing safety and training programs in various industries. Its ability to capture high-resolution, 360-degree video or images makes it a powerful tool for creating immersive training materials. For example, the camera can record realistic simulations of hazardous situations [3], as well as in other everyday activities [4]. This allows trainees to practice responses in a controlled environment without exposure to actual risks. Furthermore, the camera can be used to document and analyze workplace activities, enabling supervisors to provide immediate feedback and facilitate continuous improvement in safety practices.

In the mining industry, researchers have developed applications that utilize 360-degree cameras to capture images and videos aimed at enhancing safety training for Heavy Equipment Operators (HEO) in surface mines [5]. The study concluded that traditional training methods can be improved by incorporating 360-degree cameras.

Figure 3 displays a screenshot of a haul-truck inspection supported by 360-degree videos and images integrated into the developed applications. The camera used in this research was the predecessor of the GoPro MAX—the GoPro Fusion.

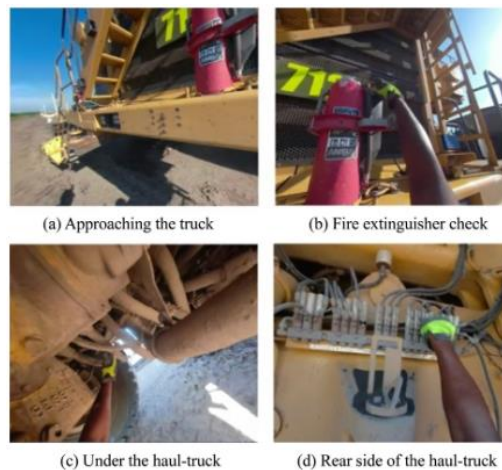


Figure 3. *Haul-Truck Inspection [5]*

In addition, researchers suggested specific camera positions for capturing 360 degrees images. An example of such positions for a haul-truck is illustrated in Figure 4 [5].

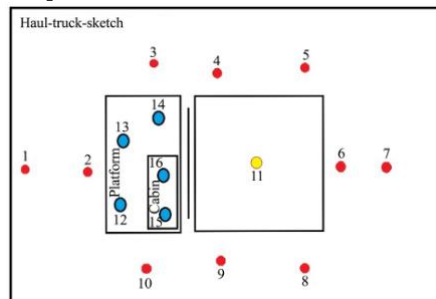


Figure 4. *Camera positions [5]*



The 360 degrees footage allows for a realistic representation of a situation, thorough understanding of the environment, ensuring that trainees are better prepared for real-world conditions.

This was also supported by research considering using 360 degrees content in construction industry [6].

4. CONCLUSION

Improving miners' safety and health is an ongoing process. This paper highlights the potential use of a 360-degree camera to capture images and videos that can enhance mine safety training. The camera's capabilities in creating immersive training content and documenting complex environments and situations, position it as a valuable asset for industries like mining, where safety and operational efficiency are paramount. While the camera may not offer the highest video resolution, its rugged design, advanced audio features, and user-friendly software make it a powerful tool for upgrading workplace training and safety in the mining industry.

ACKNOWLEDGEMENTS

This work was financially supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia, contract no. 451-03-66/2024-03/200052.

REFERENCES

- [1] GoPro MAX. (2020). Retrieved August 2024 from <https://gopro.com/en/rs/shop/cameras/max/CHDZH-202-master.html>
- [2] CNET Editors. (2024). GoPro MAX Review: A Versatile 360-Degree Camera for Action and Beyond. CNET. Retrieved august 2024
[://www.cnet.com/tech/computing/gopro-max-shoots-nice-360-video-but-thats-not-the-reason-to-get-it/](https://www.cnet.com/tech/computing/gopro-max-shoots-nice-360-video-but-thats-not-the-reason-to-get-it/)
- [3] Zujovic, Lazar, "An Interactive Mobile Equipment Task-Training with Virtual Reality" (2020). Graduate Theses, Dissertations, and Problem Reports. 7653. <https://doi.org/10.33915/etd.7653>
- [4] Tero Jokela, Jarno Ojala, and Kaisa Väänänen (2019). How people use 360-degree cameras. In Proceedings of the 18th International Conference on Mobile and Ubiquitous Multimedia (MUM '19). Association for Computing Machinery, New York, NY, USA, Article 18, 1–10. <https://doi.org/10.1145/3365610.3365645>
- [5] Zujovic, L., Kecojevic, V., & Bogunovic, D. (2021). Interactive mobile equipment safety task-training in surface mining. International Journal of Mining Science and Technology, Volume 31, Issue 4, pp. 743-751, <https://doi.org/10.1016/j.ijmst.2021.05.011>
- [6] Ricardo Eiris, Masoud Gheisari, Behzad Esmaeili (2020). Desktop-based safety training using 360-degree panorama and static virtual reality techniques: A comparative experimental study, Automation in Construction, <https://doi.org/10.1016/j.autcon.2019.102969>