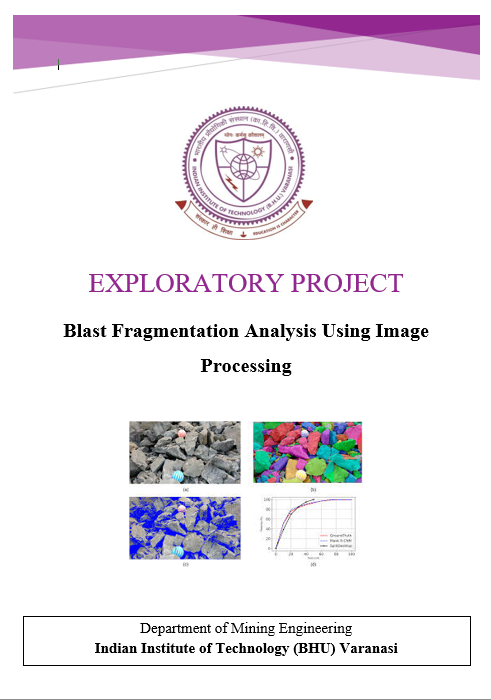
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**Design and Implementation of a Python-Based Application for Automated Measurement and Analysis of Blast Fragmentation**

**Design and Implementation of a Python-Based Application for Automated Measurement and Analysis of Blast Fragmentation**

**An Exploratory Project**

Submitted in Partial Fulfilment of the Requirements for the Degree of

***Bachelor of Technology***

In Mining Engineering

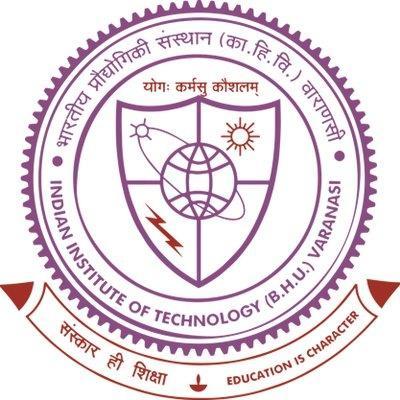
By

**GARV AGARWAL**

Roll No: 22155052 {Pt. II, Sem No.-3rd}

Under the guidance of

**Dr. Satyabrata Behera**



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Varanasi-221005, India

**November 2023**

**CERTIFICATE OF APPROVAL**

This is to certify that the thesis entitled **“Design and Implementation of a Python-Based Application for Automated Measurement and Analysis of Blast Fragmentation”** submitted by Garv Agarwal, Roll No. 22155052 in partial fulfilment of the requirements for the award of Bachelor of Technology degree in Mining Engineering at the INDIAN INSTITUTE OF TECHNOLOGY-BHU, is an authentic work carried out by him under my supervision and guidance. To the best of my knowledge, the matter embodied in the thesis has not been submitted to any other University/Institute for the award of any Degree or Diploma**.**

**Dr. Satyabrata Behera**

**Department of Mining Engineering,**

**Indian Institute of Technology (BHU) Varanasi**

**Date: -**

**Acknowledgment**

I wish to express my profound gratitude and deep sense of obligation to Dr. Satyabrata Behera of the Department of Mining Engineering at the Indian Institute of Technology (BHU) Varanasi. His presentation of the topic, along with his inspirational guidance, invaluable feedback, and instrumental support throughout the course of this project, have been truly instrumental. I am sincerely appreciative of his expert guidance and painstaking efforts, which have greatly enriched my understanding of this undertaking.

The creation of such a project would have been impossible without drawing from the knowledge and inspiration provided by the works of others, and I acknowledge my indebtedness to them all

Garv Agarwal

Roll Number:22155052

**Abstract**

The field of rock blasting in mining and quarrying operations is integral to achieving successful fragmentation, impacting downstream processes like loading, hauling, and crushing. Traditional methods for evaluating blast fragmentation face challenges in terms of efficiency and accuracy. This project introduces a novel approach by leveraging image processing algorithms and automation to enhance the precision, speed, and reliability of fragmentation analysis.

The software developed for this purpose utilizes Python, OpenCV, and Streamlit to create an interactive and user-friendly tool. The primary objectives include accurate counting of blasted rock particles. This innovative solution addresses the limitations of conventional techniques, such as sieving, and brings efficiency to the analysis process.

The project begins with a detailed exploration of the challenges in blast fragmentation analysis, highlighting the need for advanced technological solutions. The software integration into the mining industry is emphasized, showcasing its potential to optimize blasting parameters and reduce operational costs. The journey unfolds with a comprehensive discussion of the software's working principles, including image interpretation techniques, particle counting methodologies, dimensional measurements, and user interface features. Real-world applications are explored through case studies, demonstrating the software's impact on cost reduction, enhanced productivity, and its potential adaptability beyond mining scenarios.

Continuous improvement is a key focus, with updates based on user feedback and evolving industry needs. The project concludes by underlining the transformative impact of the software on decision-making processes and its versatility in various industrial contexts.

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**Chapter – 7: Conclusion**

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**Chapter-1**

**INTRODUCTION**

* 1. **Background and Motivation :-**

Imagine a scenario – the forceful impact of breaking a substantial rock into smaller fragments, a common occurrence in the realm of rock blasting within mining and quarrying operations. Yet, the narrative extends beyond the mere act of fragmentation. The essential inquiry delves into the quantification of these resultant particles and the determination of their respective widths. This meticulous analysis becomes paramount due to its direct influence on subsequent operational facets, encompassing the handling and crushing of these fractured rocks. Our project assumes the role of a figurative rock detective, unraveling this intricate puzzle by meticulously counting the smaller rocks and measuring their individual widths.

Initiating this rock-blasting venture is the recognition that merely breaking rocks falls short of optimal efficiency. The aspiration is to transcend conventional norms, particularly in the context of the seamless movement and effective crushing of these fractured rock pieces. Positioned as a solution to this multifaceted challenge [1-8], this project constitutes our proactive approach.

* 1. **Objectives of the Project: -**

In the spirit of a trusty sidekick armed with a metaphorical magical measuring tape, our project dives into the mission of not just counting the broken rock pieces but also figuring out how big they are. We're like a smart helper using computer smarts and automation, making things way easier than the old-school methods that took forever and had lots of limitations.

Our big dream? To change how mining and quarrying experts count and measure their blasted rock pieces. We want to make everything super precise and efficient, basically saving costs and making things run smoother for these industries.

So, imagine us as superheroes, using our tech-savvy tools to redefine how things are done. By introducing super-accurate ways of counting and measuring those shattered rock pieces, our project aims to shake things up in the industry. It's all about making things better, cutting costs, and boosting how smoothly these operations run.

**Chapter 2:**

**Need for Blast Fragmentation Analysis**

**2.1 Importance in Mining Operations: -**

**2.1.1 The Dynamics of Mining Operations**

Mining operations are intricate processes that extend far beyond the act of breaking rocks. It involves a meticulous orchestration of various tasks, each playing a crucial role in the overall efficiency and cost-effectiveness of the operation. At the heart of this complexity is the need for effective blast fragmentation analysis. Understanding the dynamics of mining operations reveals the interconnected nature of activities such as blasting, loading, hauling, and crushing.

The software developed addresses the core challenge of blast fragmentation by providing insights into how efficiently rocks are broken during blasting. This knowledge is fundamental for optimizing subsequent tasks and minimizing operational costs.

**2.1.2 Role of Blast Fragmentation in Downstream Activities**

Efficient blast fragmentation directly influences downstream activities in mining. When rocks are broken into well-distributed smaller fragments, tasks like loading become smoother and more efficient. The transportation and crushing of these smaller pieces are also significantly impacted. The software's ability to quantify the effectiveness of blast fragmentation plays a pivotal role in streamlining these downstream activities.

In summary, the importance of blast fragmentation analysis in mining operations is paramount. The software serves as a valuable tool to enhance the understanding of these dynamics and contribute to the overall efficiency of the mining process.

**2.2 Downstream Impact**

**2.2.1 Ripple Effect of Efficient Blast Fragmentation**

Efficient blast fragmentation sets off a ripple effect throughout the mining operation. When rocks are broken in a way that optimally distributes smaller particles, subsequent tasks seamlessly fall into place. The ripple effect ensures that each step, from loading broken rocks onto trucks to transporting and crushing them, is carried out with precision and minimal disruption.

The software's role in visualizing this ripple effect is crucial. By providing a clear representation of the distribution of smaller rock particles, it aids mining professionals in making informed decisions that positively impact downstream activities.

**2.2.2 Consequences of Inefficient Blast Fragmentation**

Conversely, inefficient blast fragmentation creates disruptions in the smooth flow of downstream activities. When rocks are inadequately broken, it leads to challenges in handling and processing the fragmented pieces. This inefficiency translates into increased operational costs, delays, and suboptimal productivity.

The software, by offering a quantitative analysis of blast fragmentation, becomes an indispensable tool for mitigating these consequences. It empowers mining operators to address inefficiencies and make adjustments for more effective and cost-efficient operations.

**Chapter-3**

**LITERATURE REVIEW**

3.1 **Traditional Methods of Blast Fragmentation Analysis**

**3.1.1 Sieving and Screening Techniques**

Traditionally, the evaluation of blast fragmentation often involved direct methods such as sieving or screening. These techniques provide accurate size distribution measurements but come with significant drawbacks. Sieving, for instance, is a time-consuming and costly process, especially when dealing with large quantities of fragmented rocks from production blasting. The software aims to overcome these limitations by introducing an automated and efficient alternative to traditional sieving methods.

**3.1.2 Observational and Empirical Models**

Another set of traditional methods relies on observational and empirical models. Engineers often visually observe muck piles immediately after blasting, estimating the size distribution based on their experience. Empirical models, like Larsson’s equation, Sedef formula, KUZ-RAM model, etc., use blasting parameters to determine size distribution. While these methods provide approximations, they lack the precision and reliability achievable through automated analysis.

3.2 **Image Processing and Automation in Mining**

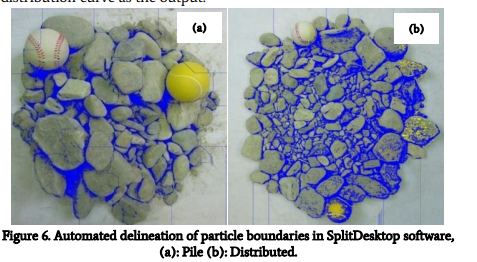
**3.2.1 Overview of Image Processing in Mining**

With advancements in technology, image processing has emerged as a powerful tool in blast fragmentation analysis. Software packages like Split Desktop, Wipf rag, Frags can, and GoldSize are based on 2D image processing, offering more efficient and accurate size distribution analysis. These tools have become prevalent in the mining industry, but there is a growing need for further automation and enhanced accuracy.

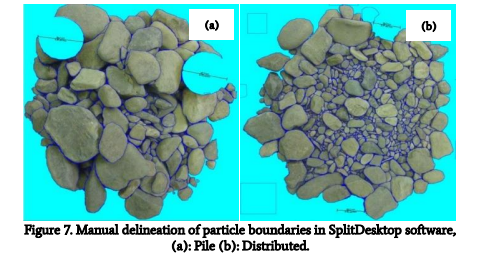
**3.2.2 Existing Software Packages in the Industry**

While software packages based on 2D image processing have been widely adopted, the limitations of these tools in terms of automation and accuracy persist. The need for more sophisticated solutions has driven the development of the software in this project, aiming to leverage advanced image processing algorithms and automation for a more precise and efficient blast fragmentation analysis.

And now what we are solving you will get idea from below

****

Below is the processed Image



**Chapter-4**

**SOFTWARE DEVELOPMENT**

**4.1 Image Processing Algorithms**

**4.1.1 Techniques for Image Interpretation**

The core of the software lies in its sophisticated image processing algorithms. These algorithms are designed to interpret images of blasted rocks, identifying and characterizing individual particles. Techniques such as thresholding, morphological operations, and distance transformation are employed to extract meaningful information about the size and distribution of rock fragments.

**4.1.2 Application of Algorithms in Fragmentation Analysis**

The application of image processing algorithms goes beyond mere interpretation. The software utilizes these algorithms to perform in-depth analysis, distinguishing between background and foreground, identifying boundaries, and generating a comprehensive map of the blast fragmentation. This level of detail allows for precise particle counting and dimensional measurements.

**4.2 Particle Counting and Dimensional Measurement**

**4.2.1 Methodology for Counting Particles**

Once the image is processed, the software employs advanced methodologies for counting individual particles. The watershed algorithm, in combination with marker labeling, is utilized to differentiate between adjacent particles and accurately count them. This approach ensures a reliable quantification of the number of blasted rock particles.

**4.2.2-Dimensional Measurement Techniques**

Beyond counting, the software excels in dimensional measurement. The watershed algorithm, applied to the distance-transformed image, enables the determination of particle boundaries. By assessing the distance between boundary points, the software calculates the diameter or width of each particle. This dimensional data provides a comprehensive understanding of the size distribution of the fragmented rocks.

**4.3 Visualization and User Interface**

**4.3.1 Display of Results**

To make the analysis accessible, the software incorporates a user-friendly visualization of results. Boundaries of individual particles are marked on the original image, allowing users to visually comprehend the distribution and size of the fragmented rocks. The inclusion of color-coding, where boundaries are highlighted in red, enhances the clarity of the visualization.

**4.3.2 User-Friendly Features**

The user interface of the software is designed with simplicity in mind. An intuitive dashboard allows users to upload images, initiate the analysis, and view results seamlessly. The inclusion of user-friendly features, such as real-time updates and interactive controls, ensures that mining professionals can efficiently navigate the software for rapid decision-making.

**4.4 Automation Features**

**4.4.1 Real-time Analysis**

Automation is a key feature of the software, enabling real-time analysis of blasted rock images. The algorithms work swiftly, providing instant feedback on the degree of fragmentation. This real-time capability is instrumental for mining operators who require immediate insights to optimize ongoing blasting operations.

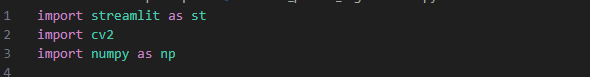
**4.4.2 Integration with Mining Processes**

The software is designed for seamless integration into existing mining processes. Its compatibility with common image formats and its ability to handle diverse datasets make it a versatile tool for various mining scenarios. The goal is to enhance the overall efficiency of mining operations by providing

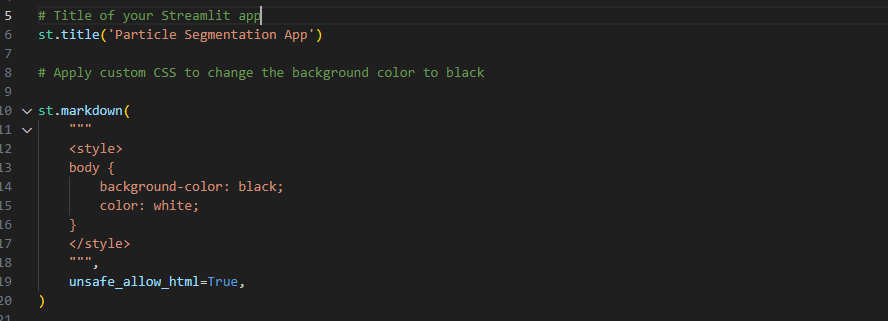
**Step By Step Process:**

Now here is the step-by-step process which I followed to complete my project: -

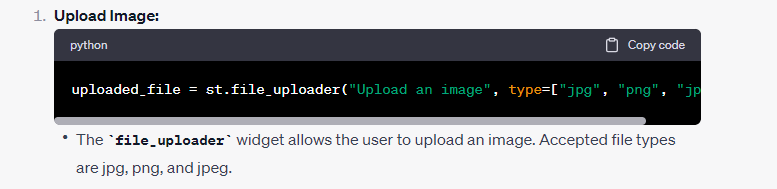
* Firstly, I had imported the libraries in my code which I will use to develop my project like streamlet and OpenCV

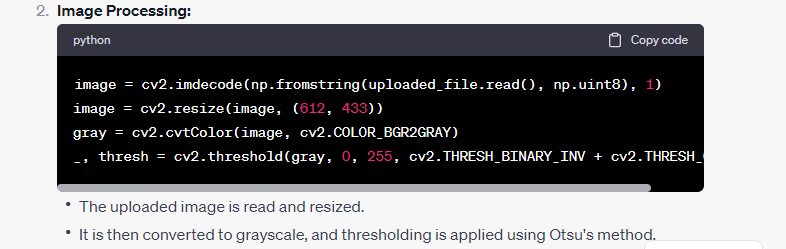


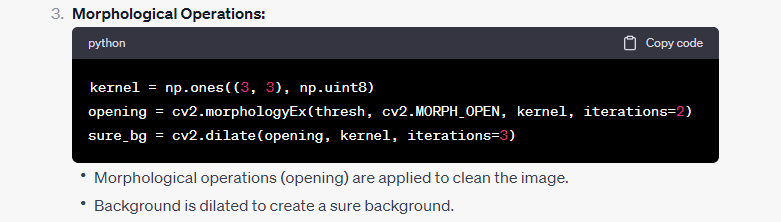
* Then I had written the CSS for my streamlit app that how it will appear when I will run it on my local host

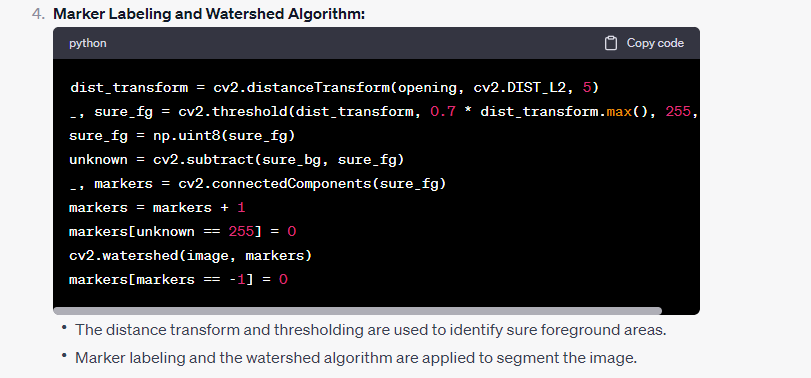


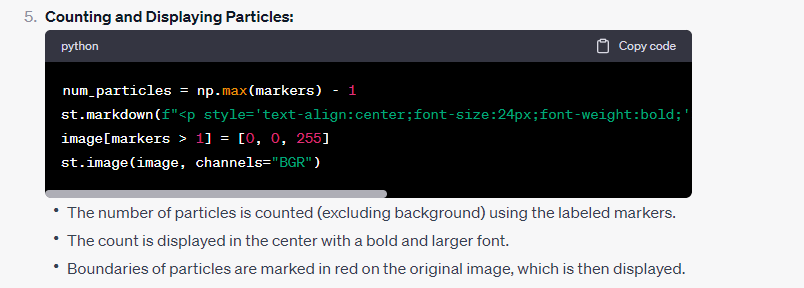
Then after that I had followed this step:





\





Now after writing the code for the functioning of my app, lastly, I had to show the result which I had derived from the code



All the code writing process are done now it’s time to run the code and validate the results, for this we are referring to the next Chapter

**Chapter-5**

**TESTING AND VALIDATION**

**5.1 Dataset Selection**

**5.1.1 Criteria for Choosing Testing Data**

The process of selecting the testing dataset involved careful consideration of various criteria to ensure a robust evaluation. Factors such as rock types, sizes, and fragmentation patterns were methodically chosen to create a dataset that authentically mirrors the diversity encountered in real mining operations. Additionally, stringent measures were applied to guarantee the integrity and quality of the testing data, providing a solid foundation for the subsequent evaluation.

**5.1.2 Diversity of Dataset**

To provide readers with a tangible understanding of the testing dataset, representative examples have been thoughtfully curated. These examples showcase the diversity in rock characteristics present in the dataset, offering a visual insight into the geological variations encompassed in the testing process. This transparency enhances the credibility of the evaluation.

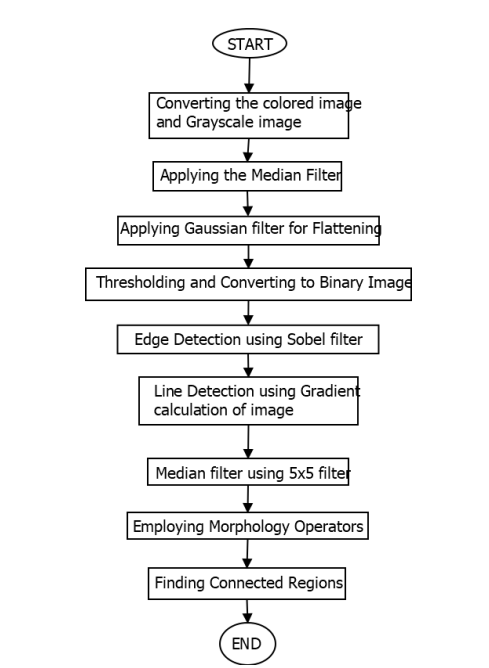
**5.2 Performance Evaluation**

**5.2.1 Comparative Analysis with Traditional Methods**

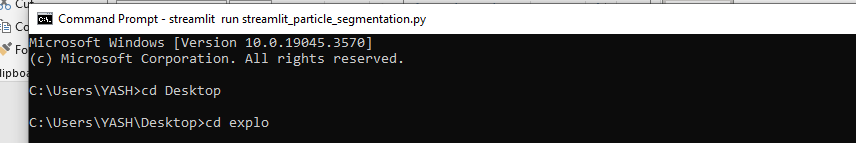
The software's performance underwent a meticulous comparative analysis against traditional methods employed in blast fragmentation analysis. Graphs and charts have been included to visually illustrate the efficiency gains achieved by the software, both in terms of time savings and enhanced accuracy. The chapter delves into the nuances of the comparison, discussing specific scenarios and challenges encountered during the evaluation, and elucidates how the software effectively addressed these challenges.

**5.2.2 Assessment of Efficiency and Accuracy**

Quantitative metrics were employed to provide a comprehensive assessment of the software's efficiency and accuracy. Parameters such as processing speed, particle counting accuracy, and dimensional measurement precision were rigorously analyzed. The chapter provides a nuanced understanding of the software's performance, discussing any observed trade-offs or limitations. This detailed analysis ensures a thorough and transparent evaluation, contributing to the credibility of the software's capabilities.



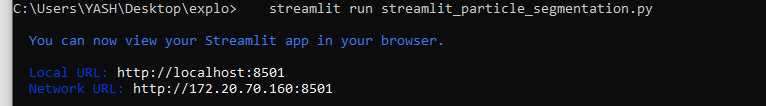
Now for running the code we have to open the CMD in our computer and write the following for changing the directory where we have our project



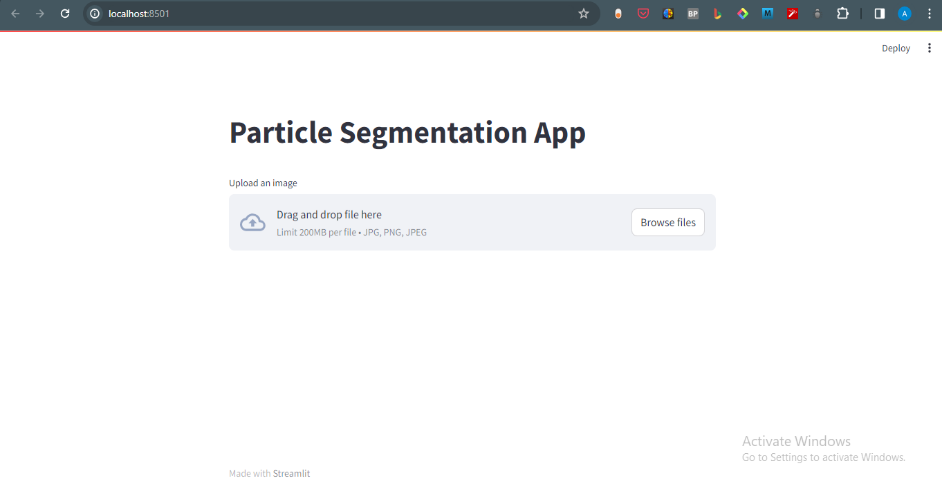
Now for running the streamlit app in our local server write the below command: -



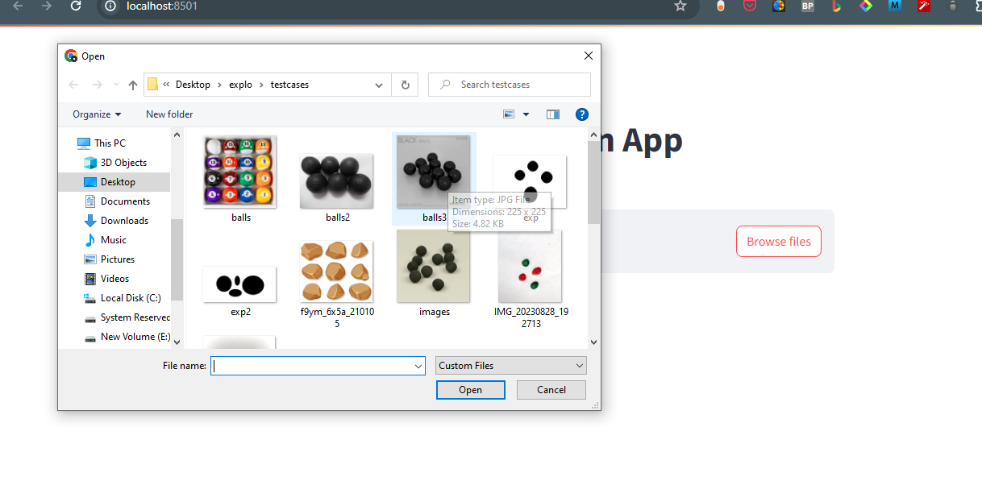
It will give us the link of our online local host where we can run our code.



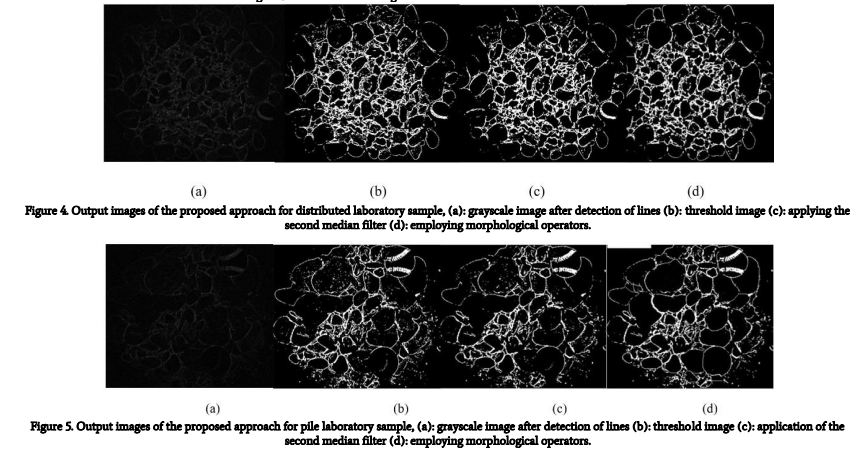
Open that link, now it’s time to run our code and see the results of it



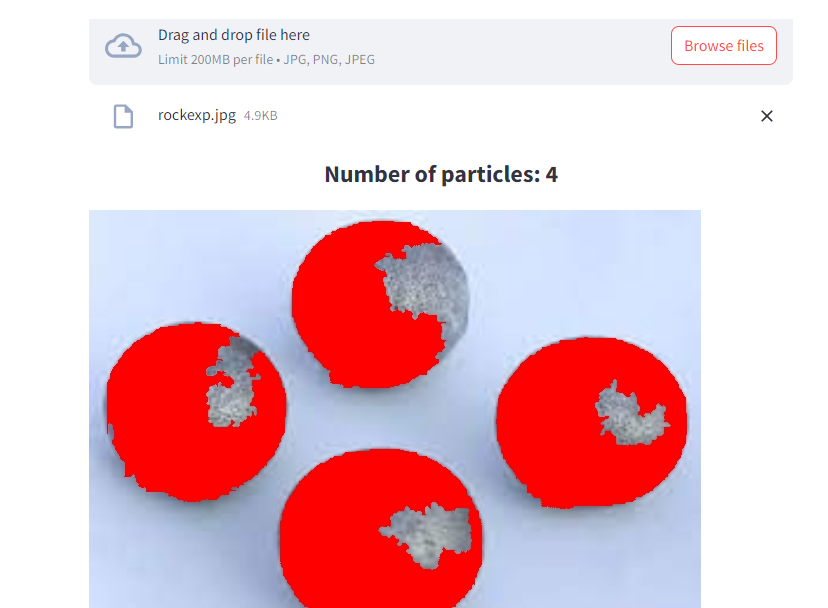
Now Click on the Browse Files option to upload the picture form your computer, before uploading check the size limitations of that.



After Choosing the one picture, let me show you what is happening behind, it is converting the image Ito grayscale and applying all the algorithms we had implemented in our code



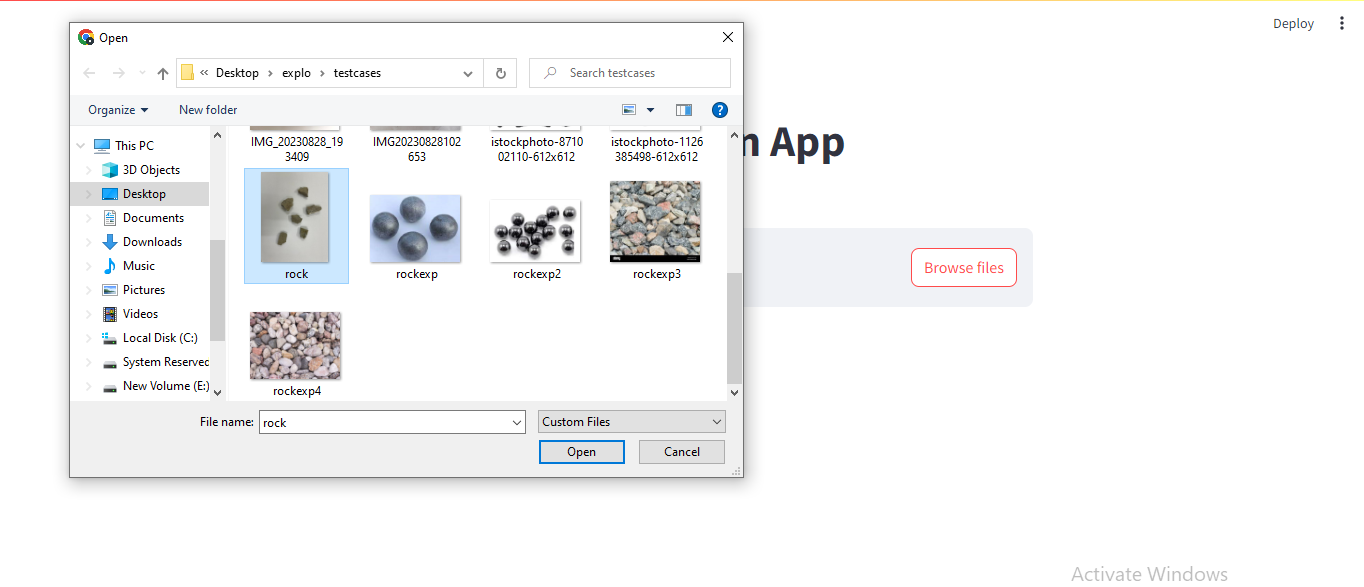
We had selected the one picture from our testcase to show the simplicity and validity of our model. Here is result below for our 1st testcase.



It is showing exactly the same number of particles and also able to identify the boundary of the particles using the Red Color.

Now without limiting this one to only one testcase, we also uploaded the second one and validate that one also

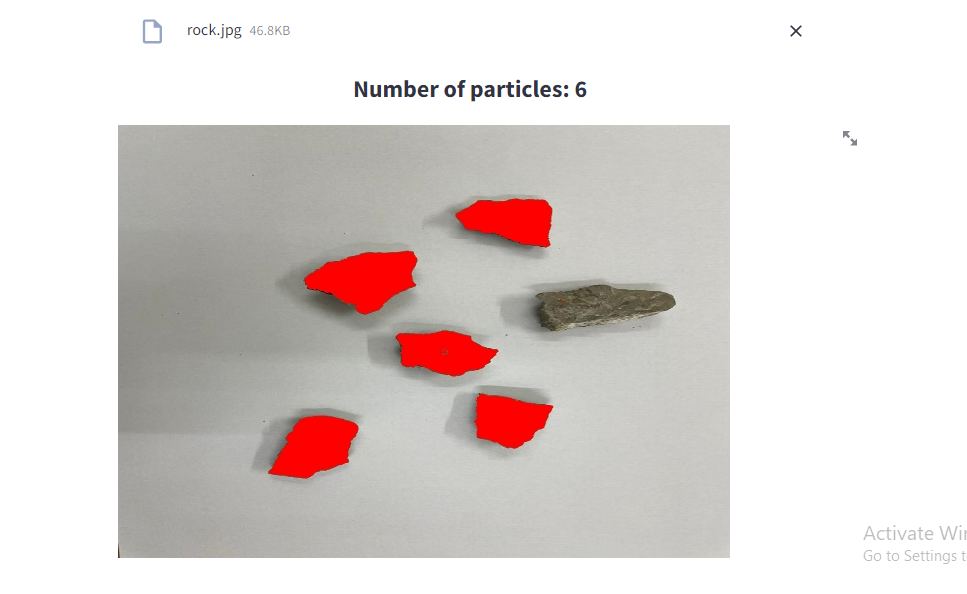






And here is the output we got for our 2nd test case also







Now if anyone wants to upload more files, they can write the code and run it on the local computer, right now we are also developing to calculate the average size of the particles. This software or the code will definitely ease the mining labor work.

--------------------------x------------------------------x--------------------------

**Chapter-6**

**REAL WORLD APPLICATIONS**

**6.1 Implementation in Mining and Other Fields**

**6.1.1 Integration into Operational Workflow**

Uncover the transformative integration of the software into the intricate operational workflow of mining activities. This section illuminates the strategic steps involved in seamlessly incorporating blast fragmentation analysis using the software.

**Step 1: Data Input**

The software integrates with mining data sources effortlessly, accepting various formats and data structures. This adaptability ensures a smooth transition into existing workflows, allowing for the direct import of relevant data from drilling, blasting, and other mining processes.

**Step 2: Real-time Analysis**

Once the data is input, the software engages in real-time analysis, providing immediate insights into blast fragmentation. This phase is crucial for decision-making, offering mining professionals a dynamic tool to assess the effectiveness of ongoing blasting operations.

**Step 3: Visualization and Reporting**

The software facilitates user-friendly visualization of results, allowing mining operators to interpret fragmentation patterns intuitively. Detailed reports are generated, providing comprehensive data on particle distribution and size. This output becomes a valuable asset for optimizing subsequent blasting parameters.

**Step 4: Seamless Adaptation**

The software's user-friendly nature ensures a seamless adaptation to existing operational workflows. Its intuitive interface and compatibility with common mining software make it an accessible and valuable addition to the mining toolkit.

**Step 5: Integration with Material Handling**

Beyond blast fragmentation analysis, envision the software seamlessly integrating with material handling processes. By providing insights into particle size and distribution, the software contributes to efficient material handling, optimizing logistics and resource allocation.

**6.1.2 Beyond Mining**

Examining the expansive impact of the software on decision-making processes, reaching far beyond the conventional boundaries of mining. Real-world scenarios highlight instances where the software's real-time analysis not only optimizes blasting parameters but extends its influence to shape broader operational decisions. Beyond the realm of mining, envision applications in the medical field, where the software proves adept at particle counting, be it red blood cells or bacteria. The software emerges as a multifaceted solution, showcasing its potential to enhance decision-making processes across a spectrum of applications, transcending industry-specific limitations.

**6.2 Implementation of the Software**

**6.2.1 Transformative Effect on Cost-Effective Fragmentation**

The introduction of the blast fragmentation analysis software has the potential to revolutionize cost-effective practices. By leveraging the software's capabilities, the quarry anticipates addressing challenges related to inefficient fragmentation. The strategic implementation of the software allows for a more precise understanding of rock particle distribution, leading to optimized blast designs. The envisioned impact includes a significant reduction in operational costs attributed to improved fragmentation patterns

**6.2.2 Realizing Productivity Gains with Automation**

The integration of the blast fragmentation analysis software promises substantial gains in productivity. The hypothetical introduction of automation features brings forth a scenario where decision-making processes within the mining operation are expedited. The software's ability to provide real-time analysis contributes to swift adjustments in blasting parameters, optimizing the entire operational workflow. The envisioned impact encompasses heightened productivity levels and streamlined downstream processes.

**6.4 Continuous Improvement and Updates**

**6.3.1 Enhanced Particle Counting and Diameter Measurement**

The software has evolved beyond its initial capabilities. Originally focused on counting the number of blasted rock particles and measuring their diameters, recent updates have significantly improved performance, especially when particles overlap. The algorithms have been fine-tuned to handle complex scenarios where fragments may intersect, ensuring a more accurate and reliable analysis.

**6.3.2 Transition to a Dynamic Model**

Acknowledging the need for real-time analysis in mining operations, the software is transitioning from a static model to a dynamic one. This next phase involves the development of a system that integrates with conveyor belts. A scanner, strategically fitted on a stand along the belt, will dynamically count and measure particles as they move. This enhancement aims to provide continuous monitoring and immediate insights, aligning with the industry's demand for increased automation and efficiency.

**6.3.3 User-Driven Adaptability**

The software's adaptability remains a cornerstone of its design. User feedback has been instrumental in shaping updates, ensuring that the software addresses the practical needs of mining professionals. The user interface has been refined for even greater simplicity, empowering operators with a tool that seamlessly integrates into their workflow.

**6..4 Embracing Evolving Technologies**

As technology evolves, so does the software. It remains at the forefront of advancements in image processing, machine learning, and automation. The development team actively explores emerging technologies to stay ahead of industry demands, ensuring the software remains a cutting-edge solution for blast fragmentation analysis.

The journey of continuous improvement is ongoing, with the software poised to make further strides in enhancing accuracy, speed, and adaptability. These updates not only reflect a commitment to meeting current industry needs but also anticipate and prepare for the future challenges and opportunities in the ever-changing technological landscape.

**Chapter-7**

**CONCLUSION**

In the concluding chapter, the software's journey unfolds as a revolutionary force in blast fragmentation analysis, redefining mining practices.

**7.1 Key Achievements**

The project started by addressing challenges in traditional fragmentation evaluation. The software, driven by image processing and automation, achieves precise particle counting and diameter measurement.

**7.2 Real-world Impact and Versatility**

Through case studies and theoretical scenarios, the software's impact extends beyond mining, showing potential applications in medical particle counting. This versatility positions it as a powerful tool with implications across diverse industries.

**7.3 Integration and Adaptability**

The software seamlessly integrates into mining workflows, becoming an accessible component. Its adaptability envisions integration with material handling processes to optimize logistics and resource allocation.

**7.4 Continuous Improvement and Future Prospects**

A commitment to continuous improvement is evident, with updates and enhancements reflecting a dynamic solution. The transition to a dynamic model, integrating with conveyor belts for real-time analysis, hints at future prospects.

**7.5 The Path Forward**

The software not only addresses blast fragmentation challenges but also sparks a paradigm shift in particle counting and measurement. The path forward involves further refinement, adapting to emerging technologies, and a commitment to efficiency and precision in various contexts.

**REFRENCES**

The completion of this project draws on a comprehensive array of scholarly and technical resources that have contributed to the understanding, development, and implementation of the blast fragmentation analysis software. These references serve as pillars supporting the project's foundation and validating the methodologies employed. The development of the blast fragmentation analysis software was enriched by leveraging various Python resources that played a pivotal role in the coding aspects. The following Python-centric references contributed significantly to the project:

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