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GEBZE TECHNICAL UNIVERSITY

FACULTY OF ENGINEERING

DEPARTMENT OF COMPUTER ENGINEERING

GLASS SURFACE DETECTION USING VISIBLE SPECTRUM CAMERAS

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SUPERVISOR
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GEBZE TECHNICAL UNIVERSITY	GRADUATION PROJECT JURY APPROVAL FORM

This study has been accepted as an Undergraduate Graduation Project in the Department of Computer Engineering on 31/08/2021 by the following jury.

JURY

Member
(Supervisor) : Dr.Yakup Genç

Member : Prof. Yusuf Sinan Akgül

ABSTRACT

This project underscores the crucial role of artificial intelligence (AI) and computer vision in revolutionizing industrial processes. AI and computer vision technologies are instrumental in automating and improving quality control, with applications spanning various sectors. In this context, the implementation of YOLO for defect detection in ceramic tiles, showcased in this report, exemplifies the transformative impact of these technologies on enhancing efficiency, reducing costs, and elevating product quality in the manufacturing industry.

Keywords: Artificial Intelligence, Computer Vision, Manufacturing Industry.

LIST OF SYMBOLS AND ABBREVIATIONS

Symbol or Abbreviation	:	**Explanation**
YOLO	:	You Only Look Once
AI	:	Artificial Intelligence

CONTENTS

LIST OF FIGURES

1. PROJECT DEFINITION

This comprehensive project is dedicated to harnessing the transformative capabilities inherent in artificial intelligence (AI) and computer vision to redefine industrial processes, with a specific focus on the manufacturing sector. The overarching goal is to revolutionize quality control through automation and efficiency improvements. A pivotal aspect of this endeavor is the implementation of YOLO (You Only Look Once), a cutting-edge object detection algorithm, for the purpose of defect detection in ceramic tiles. Beyond the technical intricacies, the project places emphasis on user accessibility by developing a user interface on the Qt framework. This graphical interface is designed to facilitate ease of use, providing an intuitive platform for users to interact seamlessly with the defect detection system. By merging advanced AI technologies with a user-friendly interface, the project endeavors to not only enhance efficiency, reduce costs, and elevate product quality but also to make these advancements accessible and user-friendly in the manufacturing industry. 1.1.

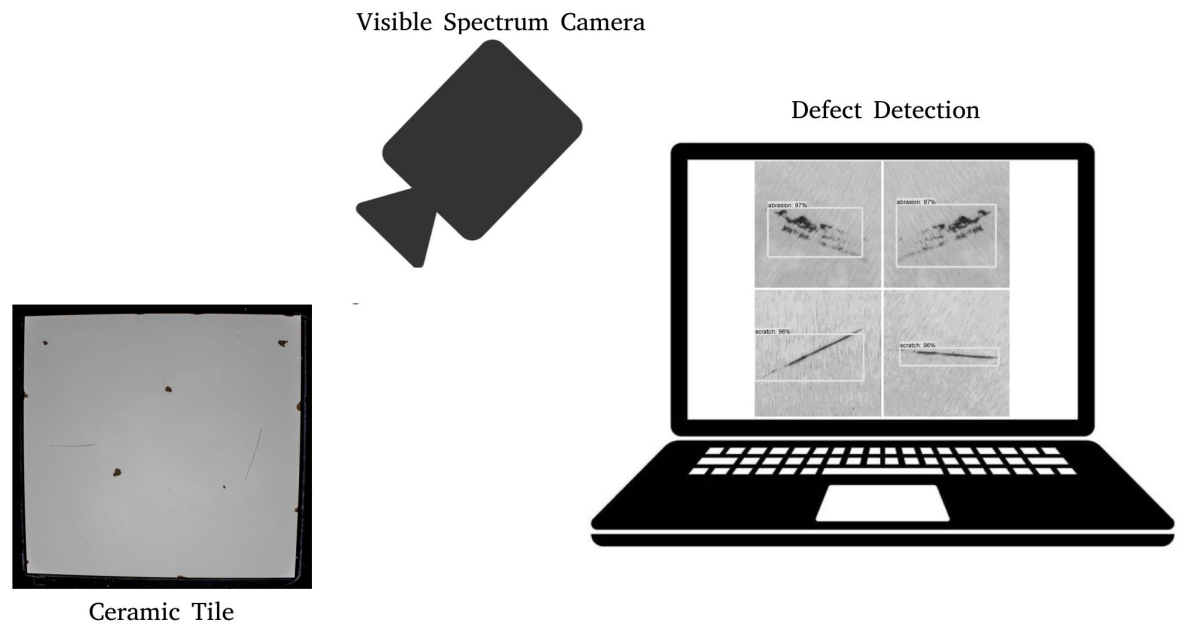

Figure 1.1: Project design plan.

2. PROJECT DETAILS

This project is developed in two sides.The model and user interface. 2.4.

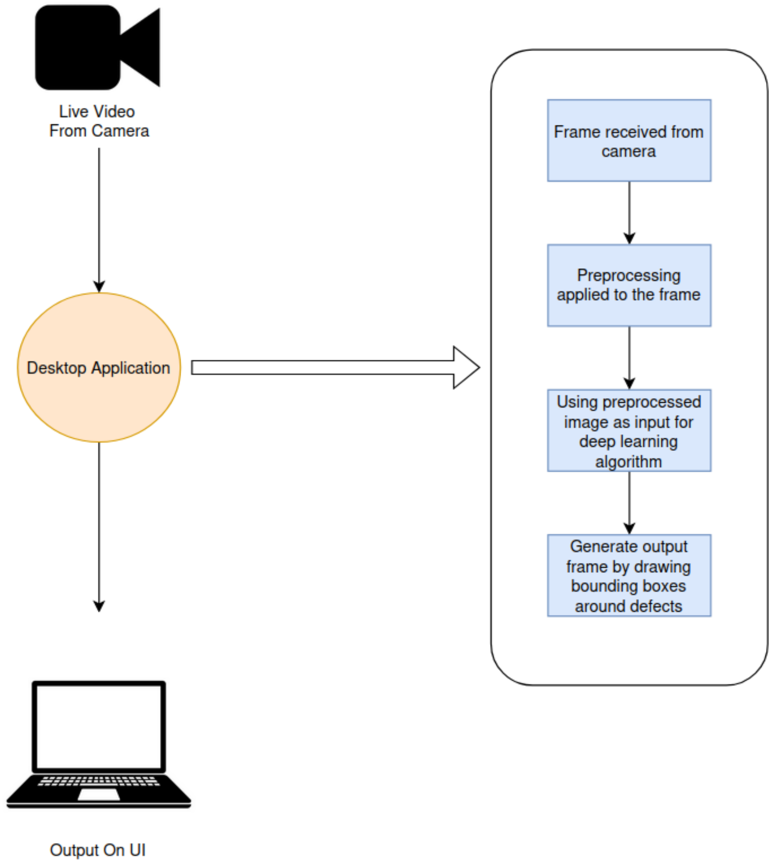

Figure 2.1: Flow diagram of the project.

2.1. The Model

In a free hour, when our power of choice is untrammelled and when nothing prevents our being able to do what we like best, every pleasure is to be welcomed and every pain avoided. But in certain circumstances and owing to the claims of duty or the obligations of business it will frequently occur that pleasures have to be repudiated and annoyances accepted. The wise man therefore always holds in these matters to this principle of selection: he rejects pleasures to secure other greater pleasures, or else he endures pains to avoid worse pains.

2.1.1. Dataset

The dataset comprises ceramic tiles exhibiting various defects and has been sourced from Roboflow, a publicly accessible platform, in the YOLOv8 format. The dataset consists of 941 images, each possessing dimensions of 3161x3147 pixels. The classification within the dataset encompasses three distinct classes: ”edge-chipping,” ”line,” and ”hole.”

2.1.2. Training Process

The Ultralytics library is employed for the training of the model, specifically utilizing the YOLOv8n architecture. The model is trained from scratch, commencing with an image size of 800 pixels and completing 200 training epochs.

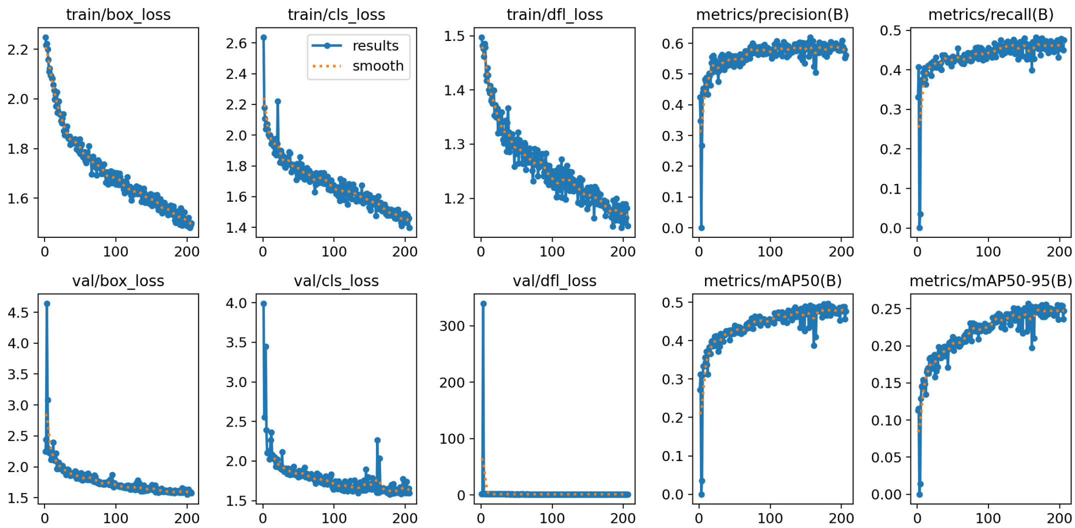

Figure 2.2: Results of the first training.

Following suboptimal performance in the initial training phase, a decision was made to iteratively refine the model. Recognizing challenges encountered during the first training iteration, such as diminished efficacy attributed to smaller image sizes causing inconspicuous defects and discrepancies in annotations, a decision was taken to retrain the model. To address the issue of small image sizes, a strategy was implemented wherein images were subdivided into quadrants, resulting in a fourfold increase in the dataset size. Simultaneously, an investigation into annotation inaccuracies was conducted through the implementation of a script, leading to the exclusion of images featuring erroneous annotations.

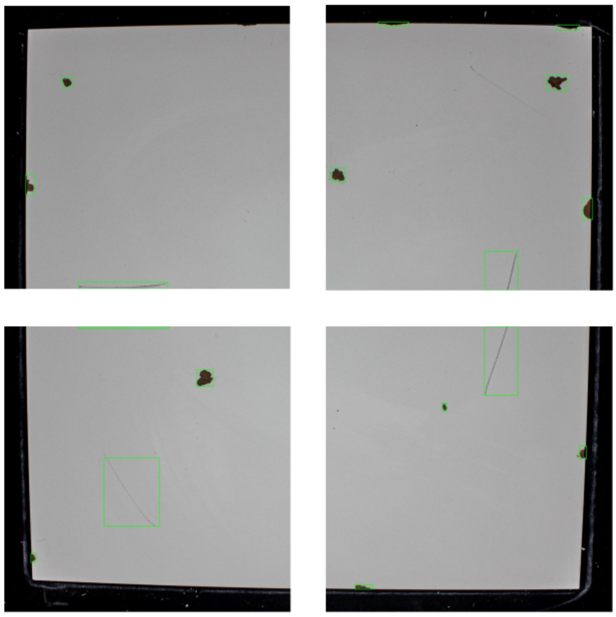

Figure 2.3: Divided training sample.

Subsequently, the refined model underwent training with augmented data, employing an increased image size of 1100 pixels, and spanning 185 epochs. These adjustments collectively contributed to a notable enhancement in the model's overall performance.However, it is crucial to note that the desired level of success was not fully achieved due to ambigious annotation of the dataset for line defects.

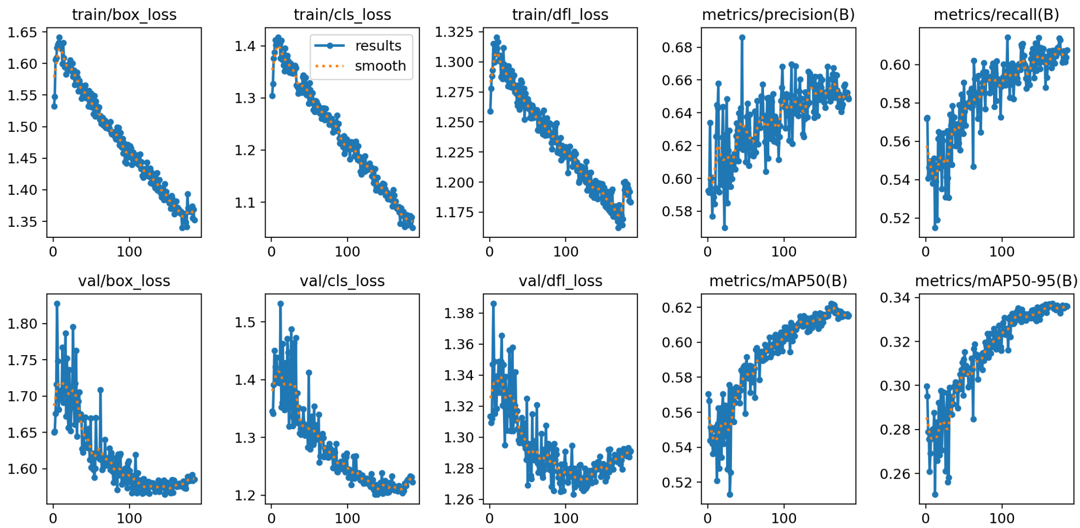

Figure 2.4: Results of the second training.

2.2. User Interface

Upon completion of the model training, a user interface designed for the detection of defects in ceramic tiles was developed using the PyQT5 library. This interface affords users the capability to select the desired resolution for object detection prior to initiating the detection process. Upon commencement of the application, real-time camera output is presented to the user, featuring the concurrent display of identified defects alongside the video frame rate. The video output is generated by capturing each frame using the CV2 library in Python. Subsequently, predictions are made, bounding boxes are drawn, and result frame rates are obtained through the implementation of the Ultralytics library.

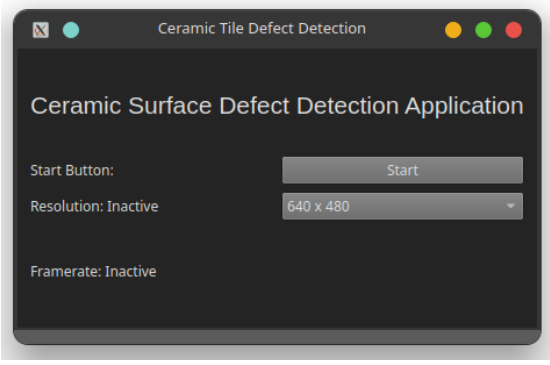

Figure 2.5: Results of the second training.

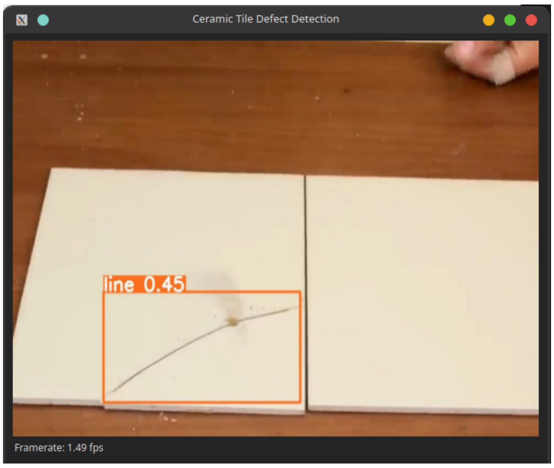

Figure 2.6: Execution of the defect detection.

3. CONCLUSIONS

In conclusion, this project has navigated the intricacies of defect detection in ceramic tiles through a multifaceted approach. Commencing with the acquisition of a comprehensive dataset from Roboflow, the project employed the YOLOv8 model and Ultralytics library for model training. Despite the challenges posed by the quality of the publicly available model and ambiguities in the labeling of the dataset, iterative refinements, including the rectification of incorrect annotations, significantly improved the model's performance. However, it is crucial to note that the desired level of success was not fully achieved due to limitations in the quality of the public model and the inherent ambiguities in the dataset labeling. Nevertheless, these efforts brought the project closer to its goals. Furthermore, the development of a user-friendly interface using the PyQT5 library enhances the accessibility of the defect detection system, allowing users to choose object detection resolutions and providing real-time feedback. The seamless integration of these components underscores the project's success in creating a more effective, albeit not fully realized, solution for defect detection in ceramic tiles. This work contributes to the ongoing advancements in quality control processes within the manufacturing industry.

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