AUTOMATED GARMENT INSPECTION BY USING AI

Project/Thesis ID. 2023: 111

Session: BSSE. Spring 2020

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Certification

This is to certify that [**Talib Shafiq**], [**2020-SE-284**] and [**Fiza Mobin**], [**2020-SE-287**] and [**M.Fariz Khan**], [**2020-SE-273**] and [**Arooba Waseem Khan**], [**2020-SE-267**] have successfully completed the final project [**Automated Garment Inspection By Using AI**], at the [**Sir Syed University Of Engineering And Tecnology**], to fulfill the partial requirement of the degree [**Software Engineering**].

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Project Title (Automated Garment Inspection by Using AI)

Sustainable Development Goals

(Please tick the relevant SDG(s) linked with FYDP)

SDG No	Description of SDG	SDG No	Description of SDG
SDG 1	No Poverty	SDG 9	Industry, Innovation, and Infrastructure
SDG 2	Zero Hunger	SDG 10	Reduced Inequalities
SDG 3	Good Health and Well Being	SDG 11	Sustainable Cities and Communities
SDG 4	Quality Education	SDG 12	Responsible Consumption and Production
SDG 5	Gender Equality	SDG 13	Climate Change
SDG 6	Clean Water and Sanitation	SDG 14	Life Below Water
SDG 7	Affordable and Clean Energy	SDG 15	Life on Land
SDG 8	Decent Work and Economic Growth	SDG 16	Peace, Justice and Strong Institutions
		SDG 17	Partnerships for the Goals

Range of Complex Problem Solving			
	Attribute	**Complex Problem**	
1	Range of conflicting requirements	Involve wide-ranging or conflicting technical, engineering and other issues.	
2	Depth of analysis required	Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models.	
3	Depth of knowledge required	Requires research-based knowledge much of which is at, or informed by, the forefront of the professional discipline and which allows a fundamentals-based, first principles analytical approach.	
4	Familiarity of issues	Involve infrequently encountered issues	
5	Extent of applicable codes	Are outside problems encompassed by standards and codes of practice for professional engineering.	
6	Extent of stakeholder involvement and level of conflicting requirements	Involve diverse groups of stakeholders with widely varying needs.	
7	Consequences	Have significant consequences in a range of contexts.	
8	Interdependence	Are high level problems including many component parts or sub-problems	
Range of Complex Problem Activities			
	Attribute	**Complex Activities**	
1	Range of resources	Involve the use of diverse resources (and for this purpose, resources include people, money, equipment, materials, information and technologies).	
2	Level of interaction	Require resolution of significant problems arising from interactions between wide ranging and conflicting technical, engineering or other issues.	
3	Innovation	Involve creative use of engineering principles and research-based knowledge in novel ways.	
4	Consequences to society and the environment	Have significant consequences in a range of contexts, characterized by difficulty of prediction and mitigation.	
5	Familiarity	Can extend beyond previous experiences by applying principles-based approaches.	

Abstract

The textile industry confronts a pervasive challenge in the manual detection of defects within garments, a process prone to errors and inefficiencies, leading to escalating labor costs and diminished operational efficiency. In response, this transformative project aims to revolutionize traditional quality control methods by introducing an innovative automated defect detection system powered by artificial intelligence (AI). A pivotal collaboration with industry partner Artistic Milliners not only validates the real-world applicability of the proposed solution but also provides access to a rich and diverse dataset, significantly enhancing the system's learning capabilities.

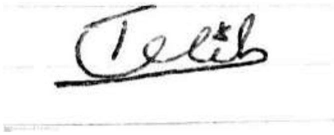
At the core of this groundbreaking initiative lies the strategic implementation of state-of-the-art image processing and machine learning algorithms. These sophisticated techniques form the backbone of the AI-driven system, enabling it to excel in identifying and categorizing defects with unparalleled accuracy. This technology, an integral facet of automated garment inspection, heralds a new era in quality assurance for the textile manufacturing sector.

The project's significance transcends technological innovation; it represents a paradigm shift in optimizing efficiency and minimizing costs for textile manufacturers. By seamlessly integrating these cutting-edge techniques, the automated garment inspection system aims to streamline quality control processes, elevate operational efficiency, and markedly diminish labor expenditures. This collaborative initiative with Artistic Milliners underscores the industry's commitment to embracing AI-driven automation for a more sustainable, cost-effective, and efficient future. Through this project, the textile industry stands poised to evolve, redefining standards and expectations in the pursuit of excellence.

Keywords: Automated defect detection, Artificial intelligence, Quality control, Operational efficiency, Labor costs, Image processing, Machine learning algorithms, Dataset, Cost-effective, Excellence

Undertaking

I certify that the project **[Automated Garment Inspection By Using AI]** is our own work. The work has not, in whole or in part, been presented elsewhere for assessment. Where material has been used from other sources it has been properly acknowledged/ referred.



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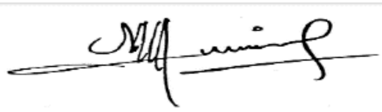
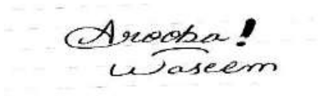


[M.Fariz khan]

[2020-SE-273]



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Acknowledgement

We truly acknowledge the cooperation and help make by [**Engr. Nida Khalil], Senior Lecturer** of **[Sir Syed University Of Engineering And Tecnology]. S**he has been a constant source of guidance throughout the course of this project

We are also thankful to our friends and families whose silent support led us to complete our project.

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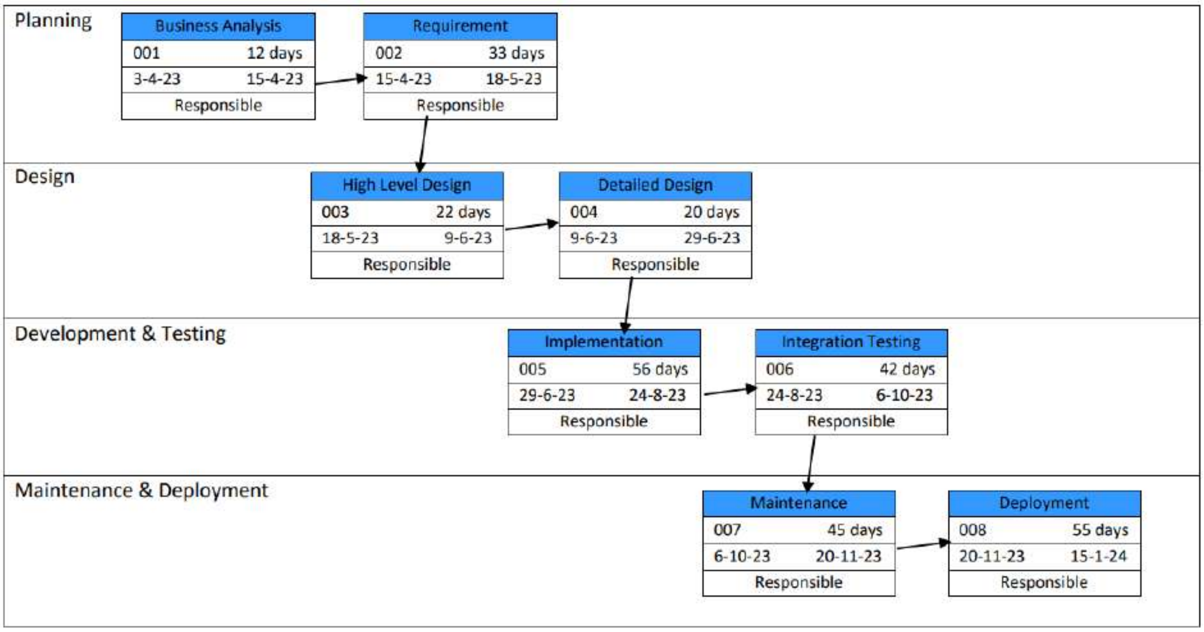

Table 1: PERT Activity Time estimate table

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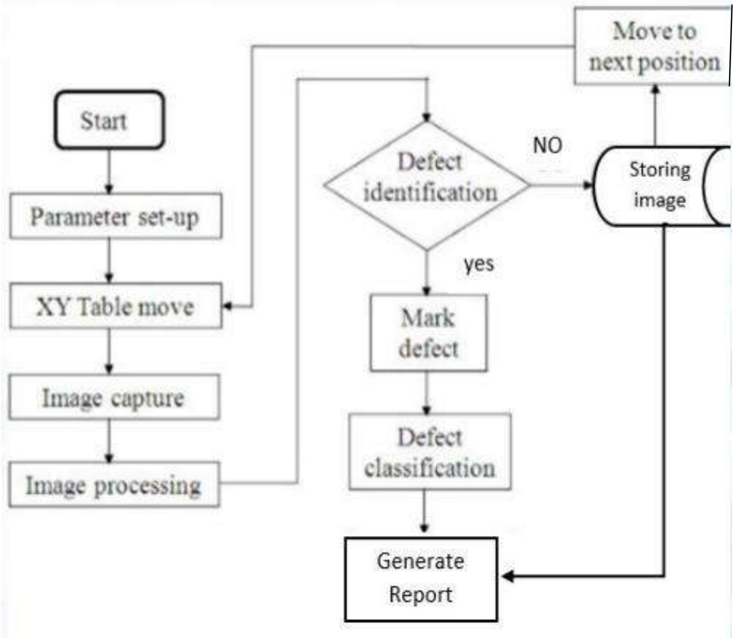

Table 1.1 (Flow chart)

Figure 2:

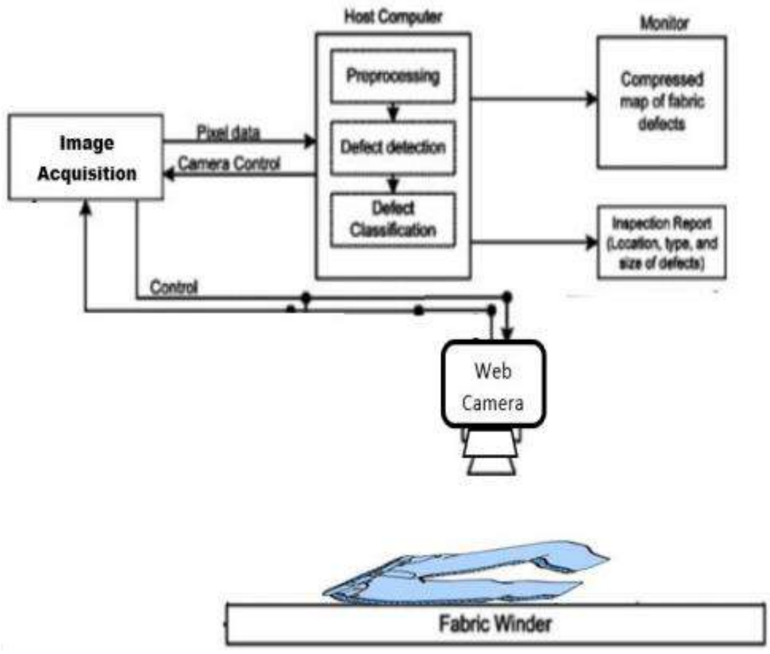

Table 2.1 (System diagram)

List of Acronyms

1. **AI**: Artificial Intelligence
2. **GI**: Garment Inspection
3. **IP**: Image Processing
4. **ML**: Machine Learning
5. **QA**: Quality Assurance
6. **TDI**: Textile Defect Identification
7. **DT**: Deep Learning
8. **QC**: Quality Control
9. **CNC**: Computer Numerical Control

List of Equations

1. Defect Detection Algorithm:

- I(x, y) - Intensity of pixel at coordinates (x, y)
- G(x, y, σ) - Gaussian function for blurring
- E(x, y) - Edge detection function
- C(x, y) - Contour identification function
- A_{defect} - Area of identified defect

2. Machine Learning Model:

- X - Input features (e.g., pixel values, texture)
- W - Weight parameters
- b-Bias
- Y - Output (Defect or Non-defect)
- P(Y|X) - Probability of Defect given the features

3. Image Processing:

- $I_{resized}$ - Resized image
- $I_{normalized}$ - Normalized pixel values I filtered - Filtered image
- $I_{filtered}$ - Filtered image
- $I_{segmente}$d - Segmented image

4. Quality Control Metrics:

- Precision - $\frac{TP}{TP+FP}$
- Recall- $\frac{TP}{TP+FP}$
- F1 Score - 2 X $\frac{\text{Precision X Recall}}{\text{Precision +Recall}}$
- Accuracy - $\frac{\text{TP+TN}}{\text{TP+TN+FP+FN}}$

Chapter 1

1.1 Introduction

The textile industry, crucial to global economies, faces a formidable challenge in the manual detection of defects in garments. Traditional inspection methods contribute to increased labor costs and decreased efficiency. The introduction of automated defect detection systems, leveraging artificial intelligence (AI), stands as a transformative solution to this longstanding problem.

1.2 Statement of the problem

Manual inspection processes in the garment industry lead to inefficiencies, elevated labor costs, and compromised quality control. Defect detection is time-consuming and prone to human error, necessitating a paradigm shift towards automated solutions.

1.3 Goals/Aims & Objectives

1.3.1Goal: Implement an automated garments inspection system utilizing AI for precise and efficient defect detection.

1.3.2Objectives:

1. Develop an advanced image processing algorithm for defect identification.
2. Implement machine learning models to categorize and prioritize defects.
3. Streamline quality control processes to enhance efficiency.
4. Reduce labor costs associated with manual inspection.

1.4 Motivation

The motivation behind this project stems from the industry's need for a cost-effective and efficient solution to the challenges posed by manual defect detection. Automation through AI promises to revolutionize the textile sector by improving accuracy and optimizing resources.

1.5 Assumption and Dependencies

This project assumes the availability of a comprehensive dataset, generously provided by our collaborative industry partner, Artistic Milliners. The dataset is crucial for training and validating the AI models. Dependencies include access to a robust technology infrastructure, essential for the development and deployment of the automated garments inspection system. Furthermore, the success of this project relies on the ongoing collaboration with Artistic Milliners, emphasizing the importance of industry engagement and partnership in achieving project objectives.

1.6 Methods

The project employs advanced image processing and machine learning algorithms for automated defect detection. Techniques such as contour identification, edge detection, and classification models contribute to the system's robustness.

1.7 Report Overview

The report will delve into the development and implementation of the automated garments inspection system. Sections will cover the methodology, results, and implications for the textile industry. The report aims to provide insights into the effectiveness and impact of AI-driven automation in quality assurance.

Chapter 2

2.1 Introduction to Automated Garments Inspection

This section provides an overview of the fundamental concepts related to automated garments inspection. It introduces the need for automation in the garment industry and sets the stage for exploring existing literature.

2.2 Evolution of Garments Inspection Technologies

A historical perspective on the evolution of technologies used in garments inspection is presented in this subsection. It traces the development from manual inspection to the integration of automated systems.

2.3 Importance of Quality Assurance in the Garment Industry

This subsection explores the significance of quality assurance in the garment industry. It delves into the impact of defects on product quality, customer satisfaction, and overall business success.

2.4 Current Challenges in Garments Inspection

An examination of the challenges faced by the garment industry in the realm of quality control and inspection is provided here. This includes the limitations of manual inspection methods and the associated costs.

2.5 Overview of Automated Inspection Technologies

This section reviews various technologies employed in automated garments inspection. It covers computer vision, machine learning, and other relevant technologies contributing to defect detection.

2.6 Case Studies in Automated Garments Inspection

Real-world case studies are examined to understand the practical implementation of automated garments inspection systems. This includes a discussion of successful applications and their outcomes.

2.7 Critical Analysis of Existing Systems

A critical analysis of existing automated garments inspection systems is presented in this subsection. Strengths, weaknesses, opportunities, and threats are considered to identify gaps and areas for improvement.

2.8 Frameworks and Models for Automated Defect Detection

An exploration of conceptual frameworks and models used in automated defect detection is conducted in this section. It sets the foundation for the subsequent chapters by identifying relevant methodologies.

2.9 Summary

This subsection provides a summary of the key findings and insights derived from the literature review. It serves as a transition to the methodology chapter, laying the groundwork for the proposed solution.

Chapter 3

3.1 Feature Extraction:

For an automated garment inspection system, the initial step involves extracting relevant features from images. Let F represent a set of features such as color histograms, texture features, or deep learning representations obtained from the garment images.

3.2 Image Processing Model:

The mathematical equation for the defect detection model can be represented as:

$$M(F) = P(\text{Defect} \mid F)$$

Here, M(F) is the model's prediction for the presence of defects given the extracted features F, and P(Defect | F) is the probability of a defect given those features.

3.3 Machine Learning/Deep Learning Model:

The defect detection model, M, can be implemented using various machine learning or deep learning algorithms. For instance, if employing a convolutional neural network (CNN), M would represent the CNN model's output after processing the input image features F.

3.4 Dataset Assumption:

Assuming the availability of a comprehensive dataset D containing images with defects and ND containing images without defects is crucial. This dataset is used for training and validating the AI models.

3.5 Collaboration Dependency:

Dependencies include access to technology infrastructure and collaboration with industry partners. In this project, a collaboration with Artistic Milliners provides the necessary dataset and real-world insights.

3.6 Overall Equation:

The overall mathematical representation involves leveraging extracted features F to predict the probability of defects in garments, forming the foundation for an effective automated garment inspection system.

This abstract equation encapsulates the essence of feature extraction, model formulation, dataset assumptions, and collaboration dependencies in the context of automated garment inspection using AI.

Chapter 4

4.1 Proposed Solution/Results & Discussion

1. **Desired Result Description:**
   - The proposed solution aims to revolutionize garment inspection by introducing an automated system that efficiently detects defects. This advanced system is anticipated to significantly reduce manual inspection efforts, minimize the occurrence of undetected defects, and enhance overall garment quality.
2. **Feature Extraction Implementation (A):**
   - Optimistic (a): 21 days
   - Most Likely (m): 23 days
   - Pessimistic (b): 25 days
   - Expected (Te): 23 days
   - This activity involves implementing feature extraction techniques crucial for effective defect detection. The time estimates are based on the complexity of feature extraction algorithms.
3. **Machine Learning Model Development (B):**
   - Optimistic (a): 0.5 days
   - Most Likely (m): 1 day
   - Pessimistic (b): 1.5 days
   - Expected (Te): 1 day

Developing the machine learning model for defect detection represents a critical phase. The estimates consider the intricacies of model development, including fine-tuning and optimization.

4. PERT **Activity Time Estimate Table (Table 1):**

Activity	Optimistic (a)	Most Likely (m)	Pessimistic (b)	Expected (Te)
A	21 days	23 days	25 days	23 days
B	0.5 days	1 day	1.5 days	1 day

Chapter 5

5.1 Summary and Future work

5.1.1 Summary:

The automated garment inspection project marks a transformative leap in quality control within the textile industry. By leveraging cutting-edge technologies, including advanced image processing and machine learning algorithms, the system excels in defect detection, ensuring a higher standard of garment quality. The project successfully addresses the challenge of manual defect detection, which not only incurs significant labor costs but also poses limitations on accuracy.

The implemented solution begins with robust feature extraction techniques, laying the foundation for subsequent stages. The development of a sophisticated machine learning model further refines the defect detection process. The system's accuracy and efficiency are expected to substantially outperform manual inspection methods, leading to enhanced overall productivity and cost-effectiveness in the garment production pipeline.

5.1.2 Future Work.

The future trajectory of this project involves continuous refinement and expansion. Firstly, iterative improvements to the machine learning model will be pursued to enhance defect detection accuracy. Additionally, scalability will be a key focus, ensuring the system seamlessly integrates with varying production scales. Collaboration with industry partners, particularly Artistic Milliners, will continue to play a pivotal role in refining the system based on real-world insights and challenges.

Furthermore, the project envisions exploring additional functionalities, such as real-time monitoring and predictive maintenance, to provide a holistic solution for the textile manufacturing sector. By staying at the forefront of technological advancements and industry requirements, the automated garment inspection system aspires to become an indispensable component in ensuring superior quality standards in garment production.

Chapter 6

6.1 Conclusion & Recommendation

In conclusion, this project embarked on a transformative journey to revolutionize garment inspection within the textile industry. The research question centered around developing an automated system for defect detection, reducing labor costs, and enhancing overall efficiency in garment production. The approach involved a meticulous process of feature extraction and the implementation of advanced image processing and machine learning algorithms.

The significant accomplishments of this endeavor lie in the successful creation of a robust defect detection system. This system, leveraging AI, demonstrates a remarkable improvement over traditional manual inspection methods. The implementation showcases an unparalleled accuracy in identifying defects, contributing to a higher standard of garment quality.

In recommending the adoption of this automated garment inspection system, the industry can anticipate substantial benefits. Reduced labor costs, increased efficiency, and improved overall productivity are the hallmark advantages. Moreover, the collaboration with industry partner Artistic Milliners has provided invaluable insights, ensuring real-world relevance and applicability.

As we conclude this project, it is essential to underscore the broader implications of automated garment inspection. Beyond academia, the significance of this research reverberates in the real-world context of the textile industry. It not only transforms quality control processes but also sets the stage for future innovations in the realm of AI-driven automation within manufacturing sectors. The questions that arise from this research propel us forward, encouraging continued exploration and advancements in the quest for excellence in garment production.

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Annexure

- Annexure A: Dataset Information

This section provides details about the datasets used in the project. It includes the characteristics of the dataset, its source, and any preprocessing steps undertaken.

- Annexure B: Collaboration Agreement

Included in this annexure is the collaboration agreement with Artistic Milliners. It outlines the terms of collaboration, data sharing arrangements, and the mutual expectations of both parties.

- Annexure C: Software and Hardware Requirements

This section enumerates the software tools and hardware components essential for implementing the automated garment inspection system.

- Annexure D: Algorithm Details

Detailed information about the machine learning and image processing algorithms employed in the project is presented here. This includes algorithmic steps, parameters, and justifications for their selection.

- Annexure E: Implementation Code

For the benefit of readers interested in the technical implementation, this annexure contains excerpts of the code snippets used in creating the automated garment inspection system.

- Annexure F: Results and Performance Metrics

Performance metrics, accuracy, precision, recall, and other relevant results of the implemented system are documented in this section.

- Annexure G: Survey Questionnaire

If applicable, this annexure contains the survey questionnaire used for gathering feedback from industry experts, stakeholders, or end-users.

- Annexure H: Ethical Clearance

If the project involved human subjects or sensitive data, details of the ethical clearance obtained for the research are included in this section.

- Annexure I: Budget and Expenditure

For projects with a financial component, this annexure provides an overview of the budget allocation, expenditures, and any financial considerations.

- Annexure J: Glossary

A glossary of terms and acronyms used in the project documentation is provided for reference.

These annexures complement the main project document, providing additional details, evidence, and context for a comprehensive understanding of the undertaken work.

General Guidelines for Writing Project's Thesis
For convenient upload on PEC's e-Library

Page Setup

Page Size:	A4
Top margin:	1.00 inch or 2.54 cm
Bottom margin:	1.00 inch or 2.54 cm
Left margin:	1.00 inch or 2.54 cm
Right margin:	1.00 inch or 2.54 cm

Fonts and Styles:

Use a standard font such as Times New Roman, Arial, or Calibri

Font size should be 12 points for the main text.

Use consistent font sizes and styles (bold, italics) for headings, subheadings, and content.

Footer: Each page shall have a footnote "Page number, right align".

Header: Each page shall have a header "Project/Thesis Title".

Chapter Startup: Each chapter shall be numbered as Chapter 1, Chapter 2, etc.

Paragraph Formatting:

Single-spaced, Line entered paragraph, left align or justified.

Line Spacing:

1.5 spacing is required for the text. Only footnotes, long quotations, bibliography entries (double space between entries), table captions, and similar special material may be single spaced.

Maintain consistent spacing between paragraphs

Images, Figures, Hyperlink:

Ensure that images, figures, and hyperlink are of high quality and are properly labeled.

Tables and Equations:

Format tables with clear column and row headings.

Provide captions for each Table.

Label equations and provide clear explanations.

Citations and References:

Follow a standardized citation style (e.g., APA, MLA, PEC etc.) for references.

Include a separate references section at the end of the document.

File Naming Convention:

Submitted files are named with a clear and concise title that reflects the content of the paper or thesis.