



**FINAL YEAR PROJECT REPORT**

# **FIRE DETECTION USING COMPUTER VISION**

**In fulfillment of the requirement  
For degree of  
BS (COMPUTER SCIENCES)**

**By**

**ALIYAN**

**72993 (BSCS)**

**HAMZA AHMED**

**72960 (BSCS)**

**MAWIZ HUSSAIN SIDDIQUI**

**72983 (BSCS)**

**SUPERVISED**

**BY**

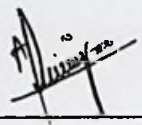
**DR. MUHAMMAD TARIQ SIDDIQUE**

**BAHRIA UNIVERSITY (KARACHI CAMPUS)**

**FALL-2024**

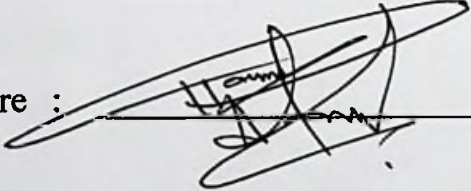
## DECLARATION

We hereby declare that this project report is based on our original work except for citations and quotations which have been duly acknowledged. We also declare that it has not been previously and concurrently submitted for any other degree or award at Bahria University or other institutions.

Signature :  \_\_\_\_\_

Name : ALIYAN

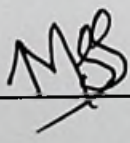
Reg No. : 72993

Signature :  \_\_\_\_\_

Name : HAMZA AHMED

Reg No. : 72960

Date : 31-Dec-24

Signature :  \_\_\_\_\_

Name : MAWIZ HUSSAIN SIDDIQUI

Reg No. : 72983

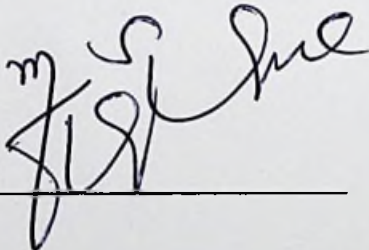
Date : 31-Dec-24



## APPROVAL FOR SUBMISSION

I certify that this project report entitled “**FIRE DETECTION USING COMPUTER VISION**” prepared by **HAMZA AHMED, ALIYAN, MAWIZ HUSSAIN SIDDIQUI** has met the required standard for submission in partial fulfilment of the requirements for the award of Bachelor of **Computer Science** at Bahria University.

Approved by,

Signature : 

Supervisor : Dr Muhammad Tariq Siddique

Date : 31/12/2024

## ACKNOWLEDGMENTS

The copyright of this report belongs to Bahria University according to the Intellectual Property Policy of Bahria University BUORIC-P15 amended on April 2019. Due acknowledgement shall always be made of the use of any material contained in, or derived from, this report.

© 2019 Bahria University. All right reserved.

## **ACKNOWLEDGEMENTS**

We would like to thank everyone who had contributed to the successful completion of this project. We would like to express our gratitude to our research supervisor, Dr Muhammad Tariq Siddique for his invaluable advice, guidance and his enormous patience throughout the development of the research.

In addition, we would also like to express our gratitude to our loving parents and friends who helped and gave us encouragement.



# **FIRE DETECTION USING COMPUTER VISION**

## **ABSTRACT**

In urban environments, fire detection is essential for public safety, as rapid identification can prevent extensive damage and save lives. Traditional fire detection methods rely on smoke sensors, which often suffer from delayed response times and limited precision, particularly in complex environments. To address these limitations, this project introduces an advanced fire detection system that combines traditional image processing techniques with deep learning models, enhancing both accuracy and speed in detecting fires. The system uses Candidate Region Detection, Feature Extraction, and Classification stages, which incorporate multiple models and techniques, including Gaussian Mixture Models, Support Vector Machines, and fine-tuned deep learning models like ResNet50 and Inception V3.

Candidate regions likely to contain fire are identified based on color and texture analysis. Fire-specific features are extracted using chromatic segmentation and texture analysis with Local Binary Patterns and Gray Level Co-occurrence Matrices. Additionally, flicker features are captured using Discrete Wavelet Transform to distinguish fire from other dynamic objects. The classification phase uses Support Vector Machines and fine-tuned CNNs to improve detection accuracy.

This system's adaptability and modularity enable it to be integrated with existing surveillance infrastructure, offering a robust solution for fire detection across various urban settings. Extensive testing shows a high level of accuracy and a significant reduction in false positives, making it suitable for real-world applications in residential, commercial, and public spaces. Future developments may involve integrating additional sensors and expanding the system's capabilities for more complex environments.

## TABLE OF CONTENTS

|                                        |           |
|----------------------------------------|-----------|
| <b>DECLARATION</b>                     | <b>2</b>  |
| <b>APPROVAL FOR SUBMISSION</b>         | <b>3</b>  |
| <b>ACKNOWLEDGEMENTS</b>                | <b>5</b>  |
| <b>ABSTRACT</b>                        | <b>6</b>  |
| <b>TABLE OF CONTENTS</b>               | <b>7</b>  |
| <b>LIST OF TABLES</b>                  | <b>10</b> |
| <b>LIST OF FIGURES</b>                 | <b>11</b> |
| <b>LIST OF SYMBOLS / ABBREVIATIONS</b> | <b>12</b> |

## CHAPTER

|          |                                            |           |
|----------|--------------------------------------------|-----------|
| <b>1</b> | <b>INTRODUCTION</b>                        | <b>13</b> |
|          | 1.1 BACKGROUND                             | 13        |
|          | 1.2 PROBLEM STATEMENTS                     | 16        |
|          | 1.3 AIMS AND OBJECTIVES                    | 19        |
|          | 1.4 SCOPE OF PROJECT                       | 19        |
| <b>2</b> | <b>LITERATURE REVIEW</b>                   | <b>22</b> |
|          | 2.1 BACKGROUND                             | 22        |
|          | 2.2 RELATED WORK                           | 23        |
|          | 2.2.1 Color Models                         | 23        |
|          | 2.2.2 Candidate Region Selection           | 26        |
|          | 2.2.3 Feature Extraction                   | 29        |
|          | 2.2.4 CNNs and ML Models                   | 31        |
|          | 2.2.5 Datasets and Real-World Applications | 34        |
|          | 2.2.6 Emerging Challenges and Solutions    | 35        |
|          | 2.3 COMPARISON TABLE WITH EXISTING STUDY   | 36        |



|          |       |                                    |           |
|----------|-------|------------------------------------|-----------|
|          | 2.3.1 | Candidate Region Detection         | 36        |
|          | 2.3.2 | Feature Extraction                 | 37        |
|          | 2.3.3 | Classification                     | 38        |
| 2.4      |       | CHAPTER SUMMARY                    | 38        |
| <b>3</b> |       | <b>REQUIREMENTS SPECIFICATIONS</b> | <b>39</b> |
|          | 3.1   | Purpose                            | 39        |
|          | 3.2   | Scope                              | 39        |
|          | 3.3   | Product Description                | 40        |
|          | 3.4   | Requirement Analysis               | 41        |
| <b>4</b> |       | <b>DESIGN AND METHODOLOGY</b>      | <b>42</b> |
|          | 4.1   | PROPOSED METHODOLOGY               | 42        |
|          | 4.1.1 | Framework Highlights               | 45        |
|          | 4.1.2 | Datasets Used                      | 45        |
|          | 4.2   | PROCESS MODEL                      | 48        |
|          | 4.3   | MODULES DISCUSSION                 | 49        |
|          | 4.3.1 | CANDIDATE REGION DETECTION         | 49        |
|          | 4.3.2 | FEATURE EXTRACTION                 | 49        |
|          | 4.3.3 | CLASSIFICATION                     | 50        |
|          | 4.3.4 | MODEL TRAINING AND VALIDATION      | 50        |
|          | 4.3.5 | INFERENCE                          | 50        |
|          | 4.4   | PROJECT DIAGRAM                    | 51        |
|          | 4.4.1 | Sequence Diagram                   | 51        |
|          | 4.4.2 | Graphical User Interface           | 52        |
|          | 4.4.3 | Gantt Chart                        | 53        |
| <b>5</b> |       | <b>SYSTEM IMPLEMENTATION</b>       | <b>54</b> |
|          | 5.1   | Defining the System                | 54        |
|          | 5.2   | Phased Implementation              | 55        |
|          | 5.3   | Ensuring Operation                 | 56        |
|          | 5.4   | Conclusion                         | 56        |



|          |                                      |           |
|----------|--------------------------------------|-----------|
| <b>6</b> | <b>SYSTEM TESTING AND EVALUATION</b> | <b>57</b> |
| 6.1      | MobileNetV2:                         | 57        |
| 6.2      | Custom CNN Architecture:             | 59        |
| 6.3      | Inception V3:                        | 61        |
| 6.4      | ResNet50 with pytorch:               | 63        |
| <br>     |                                      |           |
| <b>7</b> | <b>CONCLUSION</b>                    | <b>69</b> |
| 7.1      | Challenges and Limitations           | 69        |
| 7.2      | Future Work                          | 69        |
| <br>     |                                      |           |
| <b>7</b> | <b>References</b>                    | <b>71</b> |