

HAROHALLI, KANAKAPURA ROAD – 562112

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

(DATA SCIENCE)

**MATLAB PROJECT REPORT**

ON

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#### "Real-Time Emotion Detection from Facial Landmarks using MATLAB"

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BACHELOR OF TECHNOLOGY IN

COMPUTER SCIENCE & ENGINEERING (DATA SCIENCE)

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**HAROHALLI, KANAKAPURA ROAD – 562112**



CERTIFICATE

#### It is certified that the mini project work entitled “Real-Time Emotion Detection from Facial Landmarks using MATLAB” has been carried out at *Dayananda Sagar University*, Bangalore, by Prajwal M ENG23DS0025, Shashi Kumar ENG23DS0034, Kanishka Sharma ENG23DS0065 Bonafide student of fourth Semester, B.Tech in partial fulfilment for the award of degree in *Bachelor of Technology in Computer Science & Engineering (Data Science)* during academic year *2024-25*. It is certified that all corrections/suggestions indicated for Internal Assessment have been incorporated in the report deposited in departmental library.

#### The project report has been approved as it satisfies the academic requirements in respect of project work for the said degree.

**Signature of the Guide Signature of the Chairperson**

**ACKNOWLEDGEMENT**

A project's successful completion offers a sense of satisfaction, but it is never finished without expressing gratitude to everyone who contributed to its accomplishment. We would like to convey our sincere gratitude to our esteemed university, Dayananda Sagar University, for offering the first-rate facilities.

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**DECLARATION**

We hereby declare that the project entitled **"** Real-Time Emotion Detection from Facial Landmarks using MATLAB **"** submitted to Dayananda Sagar University, Bengaluru, is a bona fide record of the work carried out by me under the guidance of Prof. Shivamma D., Assistant Professor in the Dayananda Sagar University School of Engineering's Department of Computer Science and Engineering (Data Science). This work is submitted toward the partial fulfillment of the requirements for the award of a Bachelor of Technology in Computer Science and Engineering (Data Science).

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**ABSTRACT**

This project presents a simple and effective system for detecting human emotions in real time by analyzing facial landmarks using MATLAB. The approach begins by capturing live images of a person’s face, then automatically identifying key facial features such as the eyes, eyebrows, nose, and mouth using landmark detection techniques. By measuring the geometric relationships and distances between these landmarks, the system can recognize and classify common emotions like happiness, sadness, anger, and surprise. The method leverages MATLAB’s image processing tools for fast detection and employs machine learning algorithms to improve accuracy. This real-time emotion detection system can be applied in areas such as human-computer interaction, healthcare, and security, offering a user-friendly and responsive way to interpret emotional states from facial expressions

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**INTRODUCTION**

Facial expressions are one of the most instinctive and universal forms of non-verbal communication. They serve as powerful indicators of human emotions, often conveying feelings and intentions more effectively than spoken language. From a smile that shows happiness to a furrowed brow indicating confusion or concern, facial cues play a crucial role in social interaction and emotional exchange.With the rapid advancement of computer vision, machine learning, and artificial intelligence, it has become increasingly feasible for machines to interpret these visual cues. Emotion recognition systems aim to bridge the communication gap between humans and machines by allowing computers to detect and respond to emotional states. This capability has transformative potential across various fields, including healthcare, education, entertainment, human-computer interaction, marketing, and security.

This project focuses on building a real-time facial emotion recognition system using MATLAB. The system leverages facial landmarks—specific key points on the face such as the corners of the eyes, the position of the eyebrows, the edges of the mouth, and the tip of the nose—to analyze expressions. By tracking the movement and relative position of these features, the system can classify expressions into basic emotional categories such as **happiness, sadness, anger, surprise, fear, disgust**, and **neutral**.

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The goal of this project is to create a **simple**, **efficient**, and **accurate** framework for real-time emotion recognition using facial expressions. By integrating computer vision techniques with deep learning in MATLAB, the system demonstrates how machines can better understand human emotions—paving the way for more natural, responsive, and intelligent applications.

**OBJECTIVE AND SCOPE OF WORK**

### The main objective of this project is to develop a real-time emotion detection system that can accurately recognize and classify human emotions by analyzing facial landmarks using MATLAB. The system aims to:

### Capture live facial images through a webcam or camera.Detect and extract key facial landmarks such as the eyes, eyebrows, nose, and mouth.Analyze the geometric relationships between these landmarks to identify and classify basic emotions like happiness, sadness, anger, surprise, and others.Provide immediate feedback on detected emotions, making the system suitable for real-time applications.

### The scope of this project includes:

### Designing and implementing a facial emotion recognition algorithm using MATLAB’s image processing toolbox and machine learning tools.Integrating a live video feed to continuously capture and process facial expressions in real time.Utilizing established methods such as the Viola-Jones algorithm for face detection, and employing feature extraction techniques to identify facial landmarks.Classifying emotions based on the movement and position of facial features, and displaying the results instantly.Ensuring the system is user-friendly, efficient, and capable of running on standard computer hardware without specialized equipment.

### DESCRIPTION OF WORK

### The project follows a structured approach to detect emotions from facial landmarks in real time using MATLAB. The main steps include:

### The real-time emotion detection system begins with image acquisition, where live images or video frames are captured using a webcam integrated with MATLAB. Once the frames are collected, face detection is performed using algorithms like Viola-Jones to identify and extract the facial region, ensuring that only relevant data is processed. The extracted face images undergo preprocessing to manage variations in lighting and orientation—common techniques include resizing and histogram equalization, which help standardize the input and enhance detection accuracy. After preprocessing, the system proceeds with landmark extraction, where key facial features such as the eyes, eyebrows, nose, and mouth are identified. This is typically achieved using feature extraction methods like Local Binary Pattern (LBP) and Histogram of Oriented Gradients (HOG), which capture essential structural details of the face.

### In the feature analysis stage, the geometric relationships and distances between these landmarks are analyzed to form a feature vector that represents the emotional state. This data is then passed to the emotion classification module, where machine learning classifiers—such as Support Vector Machines (SVM) or K-Nearest Neighbors (KNN)—are employed. These classifiers are trained on labeled datasets to accurately recognize and classify emotions such as happiness, sadness, anger, and surprise. The system delivers real-time feedback, processing each frame instantly and displaying the detected emotion on-screen. Optionally, the results can also be sent to external devices like an Arduino microcontroller for interactive or assistive responses. Finally, the system features a user-friendly interface designed in MATLAB, which displays the live video feed, detected facial landmarks, and the recognized emotions, thereby enhancing usability and interaction.

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### METHODOLOGY

### The methodology for real-time emotion detection from facial landmarks using MATLAB involves several systematic steps, combining image processing and machine learning techniques for accurate and efficient results.

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### Image Acquisition: Capture real-time images or video frames using a webcam connected to MATLAB.

### 2. Face Detection: Apply the Viola-Jones algorithm to detect and extract the face region from each frame. This method is fast and reliable for real-time applications.

### 3. Preprocessing:Standardize the detected face images by handling variations in lighting and orientation. Preprocessing may include resizing, normalization, and histogram equalization to enhance feature extraction accuracy.

### 4. Landmark Detection and Feature Extraction: Extract key facial landmarks such as the eyes, eyebrows, nose, and mouth using techniques like Local Binary Patterns (LBP) and Histogram of Oriented Gradients (HOG). These features capture the geometric structure and texture of facial regions.

### 5. Feature Analysis :Analyze the spatial relationships and distances between landmarks. This geometric information is crucial for distinguishing between different emotional expressions.

### 

### 6. Emotion Classification: Employ machine learning classifiers such as Support Vector Machines (SVM) or neural networks, trained on labeled datasets, to categorize emotions (e.g., happy, sad, angry, surprised). Training involves feeding the extracted features into the classifier and optimizing its parameters for best performance.

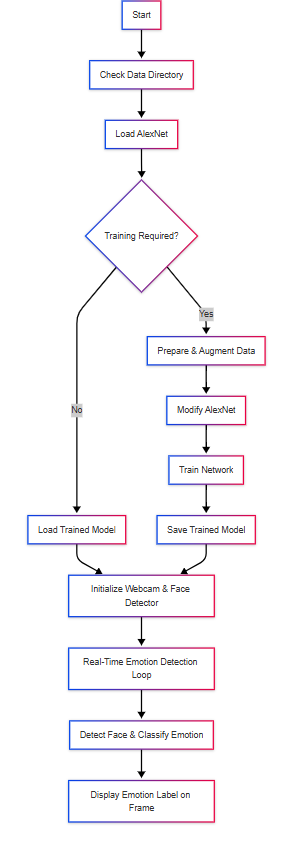
### 7. Real-Time Feedback and Display: Process each frame in real time, displaying the detected emotion instantly on the MATLAB interface. The system may also interface with external hardware (e.g., Arduino) for further actions or feedback, such as moving a camera or displaying results on an LCD.

### 8. User Interface: Develop a simple graphical user interface (GUI) in MATLAB to show live video, detected facial landmarks, and recognized emotions, ensuring ease of use for end-users.

### 9.Model Training: For model training, we utilized the FER-2013 dataset comprising labeled grayscale facial images across seven emotion categories. The dataset was preprocessed by resizing images and normalizing pixel values. A deep learning model based on transfer learning using the AlexNet architecture was employed. The network was fine-tuned on the training set using stochastic gradient descent with appropriate learning rates and batch sizes. The model was trained over multiple epochs while monitoring accuracy and loss to ensure convergence and avoid overfitting.

### 

### Flow Chart of Model

****

**SOURCE CODE**

% Set the data directory

dataDir = "/MATLAB Drive/Matlab\_project/emotion\_data";

doTraining = false;

% Check if the directory exists

if ~exist(dataDir, 'dir')

error('Data directory "%s" not found.', dataDir);

end

% Emotion categories (must match subfolder names)

emotions = {'happy', 'sad', 'angry', 'surprise', 'neutral', 'fear', 'disgust'};

numEmotions = numel(emotions);

imageSize = [227 227 3];

% Load AlexNet

try

net = alexnet;

catch

error('AlexNet not found. Install Deep Learning Toolbox and AlexNet support.');

end

1.Prepare Data

if doTraining

try

imdsTrain = imageDatastore(fullfile(dataDir, 'train'), ...

'IncludeSubfolders', true, ...

'LabelSource', 'foldernames');

imdsValidation = imageDatastore(fullfile(dataDir, 'test'), ...

'IncludeSubfolders', true, ...

'LabelSource', 'foldernames');

% Read and resize images, convert grayscale to RGB if needed

imdsTrain.ReadFcn = @(filename) repmat(imresize(imread(filename), imageSize(1:2)), [1 1 3]);

imdsValidation.ReadFcn = @(filename) repmat(imresize(imread(filename), imageSize(1:2)), [1 1 3]);

% Data augmentation

augmenter = imageDataAugmenter( ...

'RandRotation', [-20 20], ...

'RandXTranslation', [-10 10], ...

'RandYTranslation', [-10 10], ...

'RandXScale', [0.9 1.1], ...

'RandYScale', [0.9 1.1], ...

'RandXReflection', true);

datasourceTrain = augmentedImageDatastore(imageSize, imdsTrain, ...

'DataAugmentation', augmenter);

datasourceValidation = augmentedImageDatastore(imageSize, imdsValidation);

catch ME

error('Error preparing training data: %s', ME.message);

end

end

2.Modify Alexnet

if doTraining

try

layers = net.Layers;

layers(1) = imageInputLayer(imageSize, 'Name', 'input', 'Normalization', 'none');

layers(end-2:end) = [

fullyConnectedLayer(numEmotions, 'Name', 'fc\_emotion')

softmaxLayer('Name', 'softmax')

classificationLayer('Name', 'classOutput')];

catch ME

error('Error modifying network: %s', ME.message);

end

end

3.Train Network

if doTraining

try

options = trainingOptions('sgdm', ...

'MiniBatchSize', 64, ...

'MaxEpochs', 10, ...

'InitialLearnRate', 0.001, ...

'ValidationData', datasourceValidation, ...

'ValidationFrequency', 30, ...

'Verbose', false, ...

'Plots', 'training-progress');

net = trainNetwork(datasourceTrain, layers, options);

save('emotion\_detection\_network.mat', 'net');

catch ME

error('Error training network: %s', ME.message);

end

else

try

load('emotion\_detection\_network.mat', 'net');

catch ME

error('Failed to load trained model: %s', ME.message);

end

end

Real time Detection

try

cam = webcam();

cam.Resolution = '640x480';

catch ME

error('Webcam error: %s', ME.message);

end

faceDetector = vision.CascadeObjectDetector;

figure;

h = gcf;

set(h, 'Visible', 'on');

try

while ishandle(h)

frame = snapshot(cam);

faces = faceDetector.step(frame);

if ~isempty(faces)

for i = 1:size(faces, 1)

face = faces(i, :);

croppedFace = imcrop(frame, face);

if size(croppedFace, 3) == 1

resizedFace = imresize(repmat(croppedFace, [1 1 3]), imageSize(1:2));

else

resizedFace = imresize(croppedFace, imageSize(1:2));

end

label = classify(net, resizedFace);

position = [face(1), face(2) - 15];

if position(2) < 1

position(2) = face(2) + face(4) + 15;

end

% --- MODIFICATION HERE ---

frame = insertObjectAnnotation(frame, 'rectangle', face, ...

char(label), 'Color', 'white', ... % Changed 'TextBoxColor' to 'Color'

'FontSize', 14, 'TextColor', 'black');

% -------------------------

end

else

frame = insertText(frame, [10 10], 'No faces detected', ...

'FontSize', 14, 'TextColor', 'red');

end

imshow(frame);

pause(1.0);

end

clear cam;

catch ME

clear cam;

error('Real-time detection error: %s', ME.message);

end

### RESULT

### The real-time emotion detection system developed using MATLAB successfully identifies and classifies human emotions from facial expressions captured through a webcam. and Support Vector Machines (SVM) for emotion classification.

### Class Distribution

### 

### The bar chart illustrates the distribution of emotion categories in the training set of the FER-2013 dataset. It includes seven emotions: angry, disgust, fear, happy, neutral, sad, and surprise. Each bar represents the number of images available for that specific emotion. "Happy" has the highest count, followed by neutral and sad. This visualization helps understand the data availability for each class in the FER-2013 dataset used for real-time emotion detection.

### Sample Images of Each Emotion

### 

### The image shows sample grayscale images from the FER-2013 training dataset, organized by emotion categories. Each row corresponds to one of the seven emotion classes: happy, sad, angry, surprise, neutral, fear, and disgust. Multiple example faces are shown per emotion, highlighting variations in facial expressions within the same class. These real-world facial expressions help train deep learning models for emotion recognition..

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### The final implementation is able to recognize and display several basic emotions, including happy, sad, scared, angry, confused, and surprised, by analyzing the geometric relationships of facial landmarks in live video streams. The results are shown instantly on the user interface, and the system can optionally communicate with external hardware to provide physical feedback or control actions based on detected emotions.

### Testing demonstrates that the approach is fast, reliable, and suitable for real-time applications, with accurate detection and tracking of facial expressions in various lighting and background conditions. This makes the system practical for use in fields like healthcare, security, and human-computer interaction.

### CONCLUSION

### In this project, a real-time emotion detection system was successfully developed using MATLAB by analyzing facial landmarks.

### Facial Emotion Recognition (FER) technology is rapidly transforming the landscape of human-computer interaction across a broad spectrum of industries. By enabling machines to understand and respond to human emotions, FER enhances the personalization and effectiveness of services ranging from healthcare to security, and from customer service to automotive safety. As the technology continues to advance and integrate with other biometric systems, the potential for FER to enrich our daily lives and work environments grows exponentially. Embracing these developments promises to not only improve existing applications but also pave the way for innovative uses of emotion recognition in the future. With its profound impact on how we interact with technology, FER is set to redefine the boundaries of what machines can understand about the human experience.

### The results show that the approach is practical and effective for real-world applications, even under different lighting and background conditions. This work highlights the potential of emotion detection systems in areas like healthcare, security, and human-computer interaction, where understanding human emotions can make a significant difference. Overall, the project provides a solid foundation for further improvements, such as recognizing more complex emotions or integrating with other sensory data for even richer emotion analysis.

### REFERENCES

### [1] "Facial Expression Recognition (FER) using ML-HDG," MATLAB Central File Exchange, MathWorks, 2025. Available: <https://www.mathworks.com/matlabcentral/fileexchange/166321-facial-expression-recognition-fer-using-ml-hdg.>

### [2] "EMOTION DETECTION BASED ON FACIAL EXPRESSION," International Journal of Creative Research Thoughts (IJCRT), Volume 10, Issue 9, September 2022, ISSN: 2320-2882. Available: <https://ijcrt.org/papers/IJCRT2209095.pdf.>

### [3] "Facial Expression Recognition Based on MATLAB," Scientific.Net, 2014. Available[: https://www.scientific.net/AMM.543-547.2188.](about:blank)

### [4] “Transfer Learning Using Alexnet convolutional neural network “

### <https://in.mathworks.com/help/deeplearning/ug/transfer-learning-using-alexnet.html>

### [5] Fer-2013Dataset

### <https://www.kaggle.com/datasets/msambare/fer2013/data>

### [6] Micro-Facial Expression Recognition in Video Based on Optimal

### Convolutional Neural Network (MFEOCNN) Algorithm <https://arxiv.org/abs/2009.13792>

### [7] Facial Expression Recognition Based on MATLAB

### <https://www.scientific.net/AMM.543-547.2188>

### [8] Face, Age, and Emotion Detection - MATLAB Central File

### Exchange <https://www.mathworks.com/matlabcentral/fileexchange/71819-face-age-and-emotion-detection>

### [9] Facial Expression Emotion Detection for Real-Time Embedded

### Systems: <https://www.mdpi.com/2227-7080/6/1/17>