BMS INSTITUTE OF TECHNOLOGY, BANGALORE-560064

Students Project Review and Assessment Committee

Intermediate Report-Phase I

Batch No: 8	Guide Name: Dr. Anupama H S	Submission Date:
Project Title EMOTION DETECTION USING FACIAL EXPRESSIONS		

Sl No	USN	Name
1	1BY19AI017	Diya Jaikumar
2	1BY19AI040	Puja S
3	1BY19AI048	Sanjeevini Raghavendra
4	1BY19AI049	Satyam Singh
Project Execution Place		In-house
Project Category		Application Project

Signature of HoD **Signature of the Guide** **SPARC**

BMS INSTITUTE OF TECHNOLOGY & MANAGEMENT

Yelahanka, Bangalore – 560 064

Department Name

Artificial Intelligence and Machine

Learning Synopsis for the Project work

"EMOTION RECOGNITION USING FACIAL EXPRESSIONS"

Submitted By:

Ms.Diya Jaikumar	**[1BY19AI017]**
Ms.Puja S	**[1BY19AI040]**
Ms.Sanjeevini Raghavendra	**[1BY19AI048]**
Mr.Satyam Singh	**[1BY19AI049]**

Under the Guidance of

Dr. Anupama H S
Associate Professor
Dept. of AI&ML

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ABSTRACT

Emotion recognition is the process of identifying human emotion. People vary widely in their accuracy at recognizing the emotions of others. Use of technology to help people with emotion recognition is a relatively nascent research area. Generally, the technology works best if it uses multiple modalities in context. To date, the most work has been conducted on automating the recognition of facial expressions from video, spoken expressions from audio, written expressions from text, and physiology as measured by wearables.

Emotion recognition is probably the best outcome if applying multiple modalities by combining different objects, including text (conversation), audio, video, and physiology to detect emotions.

- Emotion recognition in text

Text data is a favorable research object for emotion recognition when it is free and available everywhere in human life. Compared to other types of data, the storage of text data is lighter and easy to compress to the best performance due to the frequent repetition of words and characters in languages. Emotions can be extracted from two essential text forms: written texts and conversations (dialogues). For written texts, many scholars focus on working with sentence level to extract "words/phrases" representing emotions.

- Emotion recognition in audio

Different from emotion recognition in text, vocal signals are used for the recognition to extract emotions from audio.

- Emotion recognition in video

Video data is a combination of audio data, image data and sometimes texts.

- Emotion recognition in conversation

Emotion recognition in conversation (ERC) extracts opinions between participants from massive conversational data in social platforms, such as Facebook, Twitter, YouTube, and others. ERC can take input data like text, audio, video or a combination form to detect several emotions such as fear, lust, pain, and pleasure.

INTRODUCTION

Interpersonal interaction is oftentimes intricate and nuanced, and its success is often predicated upon a variety of factors. These factors range widely and can include the context, mood, and timing of the interaction, as well as the expectations of the participants. For one to be a successful participant, one must perceive a counterpart's disposition as the interaction progresses and adjust accordingly. Fortunately for humans this ability is largely innate, with varying levels of proficiency. Humans can quickly and even subconsciously assess a multitude of indicators such as word choices, voice inflections, and body language to discern the sentiments of others. This analytical ability likely stems from the fact that humans share a universal set of fundamental emotions.

Significantly, these emotions are exhibited through facial expressions that are consistently correspondent. This means that regardless of language and cultural barriers, there will always be a set of fundamental facial expressions that people assess and communicate with. After extensive research, it is now generally agreed that humans share seven facial expressions that reflect the experiencing of fundamental emotions. These fundamental emotions are anger, contempt, disgust, fear, happiness, sadness, and surprise. Unless a person actively suppresses their expressions, examining a person's face can be one method of effectively discerning their genuine mood and reactions.

Facial emotion recognition software is used to allow a certain program to examine and process the expressions on a human's face. Using advanced image dispensation, this software functions like a human brain that makes it capable of recognizing emotions too. The universality of these expressions means that facial emotion recognition is a task that can also be accomplished by computers. Furthermore, like many other important tasks, computers can provide advantages over humans in analysis and problem-solving. Computers that can recognize facial expressions can find applications where efficiency and automation can be useful, including in entertainment, social media, content analysis, criminal justice, and healthcare. For example, content providers can determine the reactions of a consumer and adjust their future offerings accordingly. It is important for a detection approach, whether performed by a human or a computer, to have a taxonomic reference for identifying the seven target emotions. Emotion recognition can detect and recognize different facial expressions using Facial Expression Analysis. Below is a table showing emotions along with their common corresponding facial expressions:

Emotion	Facial Expression
Anger	Lowered and burrowed eyebrows Intense gaze Raised chin
Joy	Raised corners of mouth into a smile
Surprise	Dropped jaw Raised brows Wide eyes
Fear	Open mouth Wide eyes Furrowed brows
Sadness	Furrowed brows Lip corner depressor
Anxiety	Biting of the lips

Facial emotion detection technology is becoming more and more advanced every year. The AI detects and studies the expressions depending on many factors to conclude what emotion the person is showing. Factors such as:

- Location of the eyebrows and eyes
- Position of the mouth
- Distinct changes of the facial features

The study held in 2012 regarding emotion recognition summarized the system's algorithm as follows:

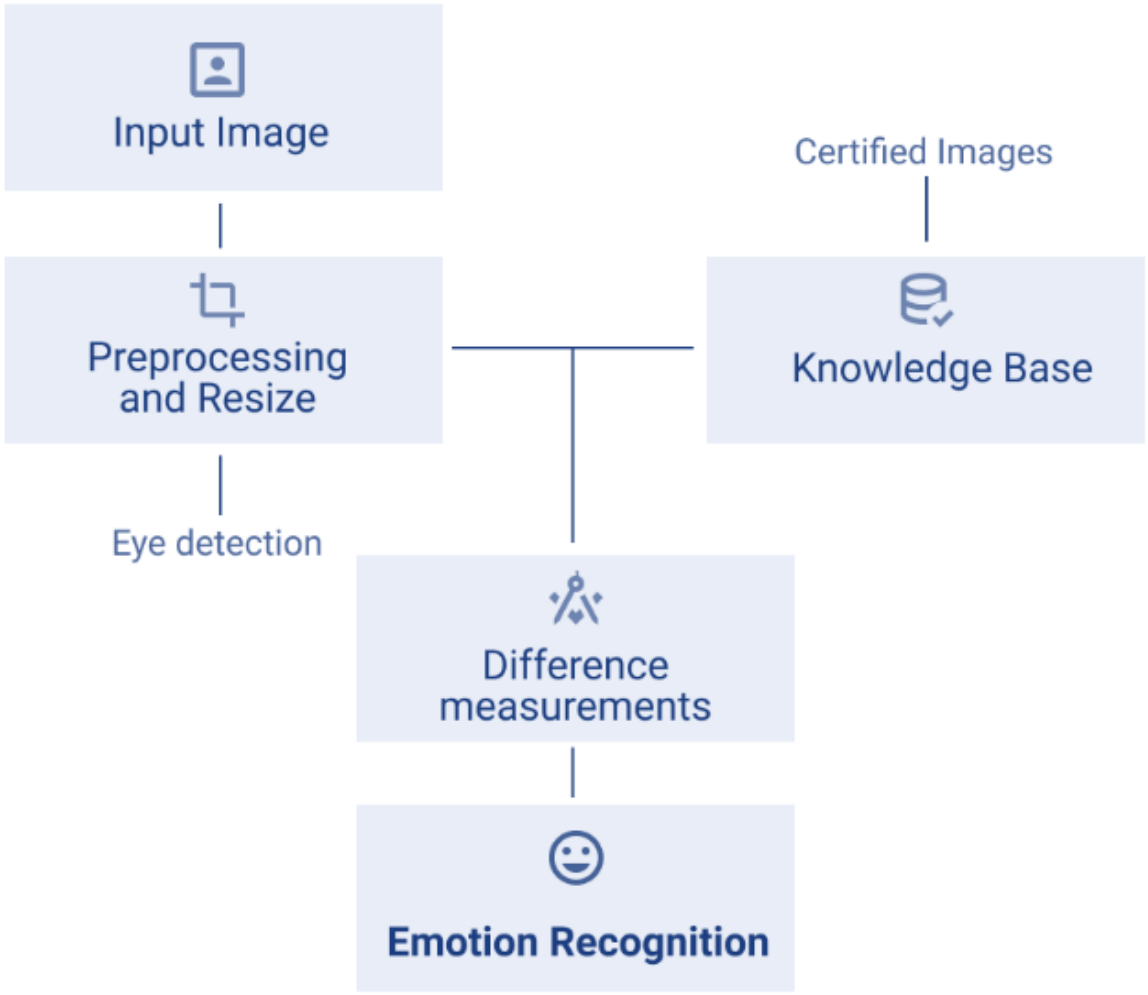

Figure 1. Emotion Recognition System's Algorithm

Knowledge Base: This base contains images that are used for comparison and recognizing emotion variations. The images are stored in the database. Every time an input is given to the system, it finds

a relevant image from its knowledge base by comparing the stored pictures and the input to come up with an output.

Preprocessing and Resize: This step enhances the input and removes different types of noises. After that, the input image will be resized, typically with the use of the eye selection method.

Difference Measurement: During this step, the system will find any differences between the input image and the stored images and will finally lead to the emotion recognition step.

Emotion Recognition: This is the final step of the process. The comparison is made, and the final output is given depending on the differences found.

Just like any developing technology, emotion recognition is not perfect and has its imperfections and challenges. One of the challenges is that datasets are labeled by the people, and different persons can read and interpret emotions in different ways. Also, some visible visual cues like furrowed eyebrows can mean other emotions aside from anger, and other cues may be subtle hints of anger, although they are not obvious. Another issue faced by this technology is when detecting emotions from people of different colors. There are models that detect more anger in black people. This means that training sets need to be more diverse, and experts are already doing what they can to fix this.

Emotion recognition provides benefits to many institutions and aspects of life. It is useful and important for security and healthcare purposes. Also, it is crucial for easy and simple detection of human feelings at a specific moment without actually asking them.

PROBLEM STATEMENT

To predict the correct facial expression out of the seven universal facial expressions using pre-set feature points for the detected face.

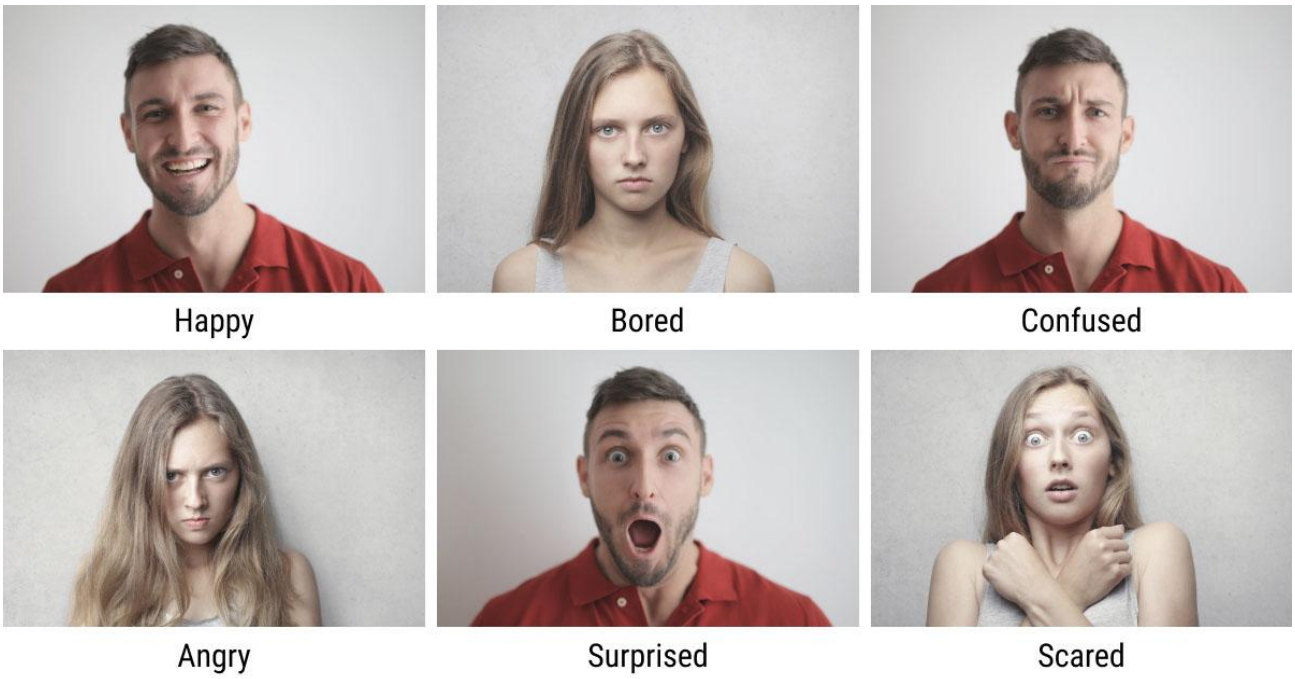

Figure 2: The six universal facial expressions

OBJECTIVES

The objective of our model is given as follows:

1. To create a system for recognising facial expressions.
2. To investigate machine learning methods in computer vision fields.
3. In order to recognise emotion and enable intelligent human-computer interaction.
4. To detect the expression of a patient during any medical procedure.

LITERATURE REVIEW

There is a wealth of material on face tracking and detection that has been the subject of intense research. The lack of data on spontaneous expression is the main issue the researchers are dealing with. Unpredictable facial emotions are one of the hardest things to capture on film and in photos. There have been numerous attempts to identify facial expressions. For the purpose of recognising facial expressions, Zhang et al. explored two categories of features: geometry-based features and Gabor wavelet-based features.

Face detection techniques include appearance-based approaches, feature-invariant techniques, knowledge-based techniques, and template-based techniques, whereas expression detection techniques include local binary pattern phase correlation, Haar classifier, AdaBoost, and Gabor Wavelet. Emotient, Affectiva, Karios, etc. are some of the API's for expression recognition, while Face Reader is the industry leader for automatic analysis of facial expression detection. The encoding of facial features and the classifier problem are two essential components of automatic facial expression recognition.

In order to describe faces, a set of suitable features must be extracted from the original face photos. The techniques utilized for representing facial features are Histogram of Oriented Gradient (HOG), SIFT, Gabbor Fitters, and Local Binary Pattern (LBP). LBP is a straightforward yet highly effective texture operator that labels each pixel in an image by thresholding its immediate surroundings and treating the result as a binary number. By thresholding the 3X3 neighborhood around each pixel with its center value and treating the result as a binary number, the operator labels the pixels in a picture. Dalal and Triggs initially proposed HOG in 2005. HOG assigns a numerical value to the appearance of gradient orientation along a local image path.

TITLE AND AUTHOR	SUBMITTED TO	YEAR	METHODOLOGY	CONCEPT USED
[6] Hybrid-Deep Learning Model for Emotion Recognition Using Facial Expressions Garima Verma & Hemraj Verma	IEEE	August 2020	The proposed model was trained on the FER2013 and Japanese female facial expression (JAFFE) datasets with results suggesting its capability of predicting emotions from facial expressions better than existing state-of-the-art approaches.	CNN
[11] A Literature Survey on Facial Emotion Recognition	Journal of Emerging Technologies and Innovative Research	April, 2019	It uses the concept of computer vision and machine learning to identify the emotions of the person based on his/her facial expression.	HOG vector algorithm, Viola Jones algorithm, KNN algorithm
[7] Emotion recognition using facial expressions with active appearance models	University of North Carolina Wilmington	Octobe r 2018	Parameters from the AAM are used as features for a classification scheme that is able to successfully identify faces related to the six universal emotions	AAM
[9] A Literature review on Emotion Recognition For Various Facial Emotional Extraction G.Kalaivani,S.Sathyapriy a, Dr.D.Anitha	IOSR Journal of Computer Engineering (IOSR-JCE)	April, 2018	The research work is implemented in three stages; image preprocessing, mouth region segmentation and identifying the emotion.	Edge based segmentation and Morphological operations

[10] Facial Emotion Recognition: A survey and a Real-World User Experiences in mixed reality Dhwani Mehta, Mohammad Faridul Haque Siddiqui, and Ahmad Y. Javaid	PubMed Central	Feb, 2018	Uses a popular mixed reality device known as Microsoft HoloLens (MHL). Depth sensors allows the development of new algorithms for the identification of human pose, gestures, face, and facial expressions	It uses various algorithms such as Support Vector Machine (SVM), Neural Networks, and Random Forest Search
[5] Emotion recognition using facial expressions Paweł Tarnowski, Marcin Kołodziej, Andrzej Majkowski, Remigiusz J.Rak	International Conference on Computational Science,Zurich, Switzerland	June 2017	The features have been calculated for a 3D face model. The classification of features were performed using K-NN Classifier and MLP neural network	K-NN and MLP
[8] Emotion Recognition from Facial Expressions using Multilevel HMM Ira Cohen, Ashutosh Garg, Thomas S. Huang	University of Illinois	September 2016	Expression Recognition Using Emotion Specific HMM.Automatic Segmentation and Recognition of Emotions Using Multilevel H	HMM

Table 1: Overview of Research Papers

LIMITATIONS OF EXISTING SYSTEM

1. Different Face Angles Can Degrade the Reliability of Facial Recognition- The algorithm's capacity to create a face template is impacted by any view other than a frontal view. The score of any ensuing matches increases with the directness and resolution of the image.
2. Facial recognition technology may be limited by data processing and storage- High-definition video takes up a lot of disc space despite having a resolution that is much lower than that of digital camera photographs. Only a small portion of a video's frames are often actually processed through a recognition system because processing every frame would be a massive undertaking.
3. The Effectiveness of Facial Recognition is Limited by Poor Image Quality- Image quality affects how well facial-recognition algorithms work. The image quality of scanning video is quite low compared with that of a digital camera.
4. Illumination- If the illumination tends to vary, the same individual gets captured with the same sensor and with an almost identical facial expression and pose, the results that emerge may appear quite different.

RESEARCH GAP AND CHALLENGES

In the above sections, we have explained the most recent techniques for emotion detection based on facial expression and recognition with the goal of finding their limitations and further scope of improvement. The methods are studied and compared above. The most important performance metric for any method is recognition accuracy. It is observed that accuracy performance of different methods, we have below observations:

- The methods that are robust are having poor performance for recognition accuracy.
- The methods with better accuracy (in 90's), suffering from the efficiency and robustness for recognition.
- Most methods are not evaluated for processing time which is also important for any facial expression and emotion recognition methods.
- Some video-based methods evaluated using image based datasets.
- Overall accuracy is approximately near to 95 %, which is still required to be enhanced further.

PROPOSED SYSTEM ARCHITECTURE & METHODOLOGY

Through the identification of facial landmarks and the use of artificial intelligence and deep learning, pixels of important facial regions are analyzed to classify facial expressions. Examples of facial landmarks used to detect emotions include the nose, mouth, and chin. A careful analysis of the combination of different landmarks through Al and ML can help differentiate between similar-appearing but distinct emotions as well as similar-appearing but different emotions.A complex example of an emotion is "disgust", which is identified through a combination of facial features that include eyebrows being pulled down, a nose being wrinkled, the upper lip being pulled up, and lips being loose. Facial recognition can be a beneficial tool in studies in order to find out the emotions people are feeling. , but it is not always an effective tool.

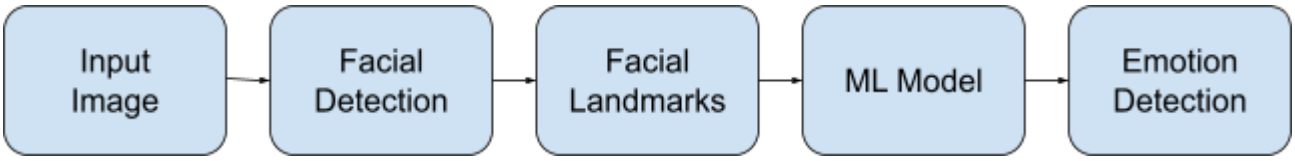

Figure 3: Workflow

There is three main steps in Emotion detection:

- Image Pre-processing
- Feature Extraction
- Feature Classification

The image is given as an input to the model. Then it goes through pre-processing that is facial detection and then planting the facial landmarks on the detected face. When this is done we use the ML model through which the image will go through, and the required feature of the face will be extracted from the input image. Now, the extracted features are used to classify the image i.e., to tell what the emotion on the face is which was given as the input.

The following figure shows the system design for a real-time emotion recognition system.

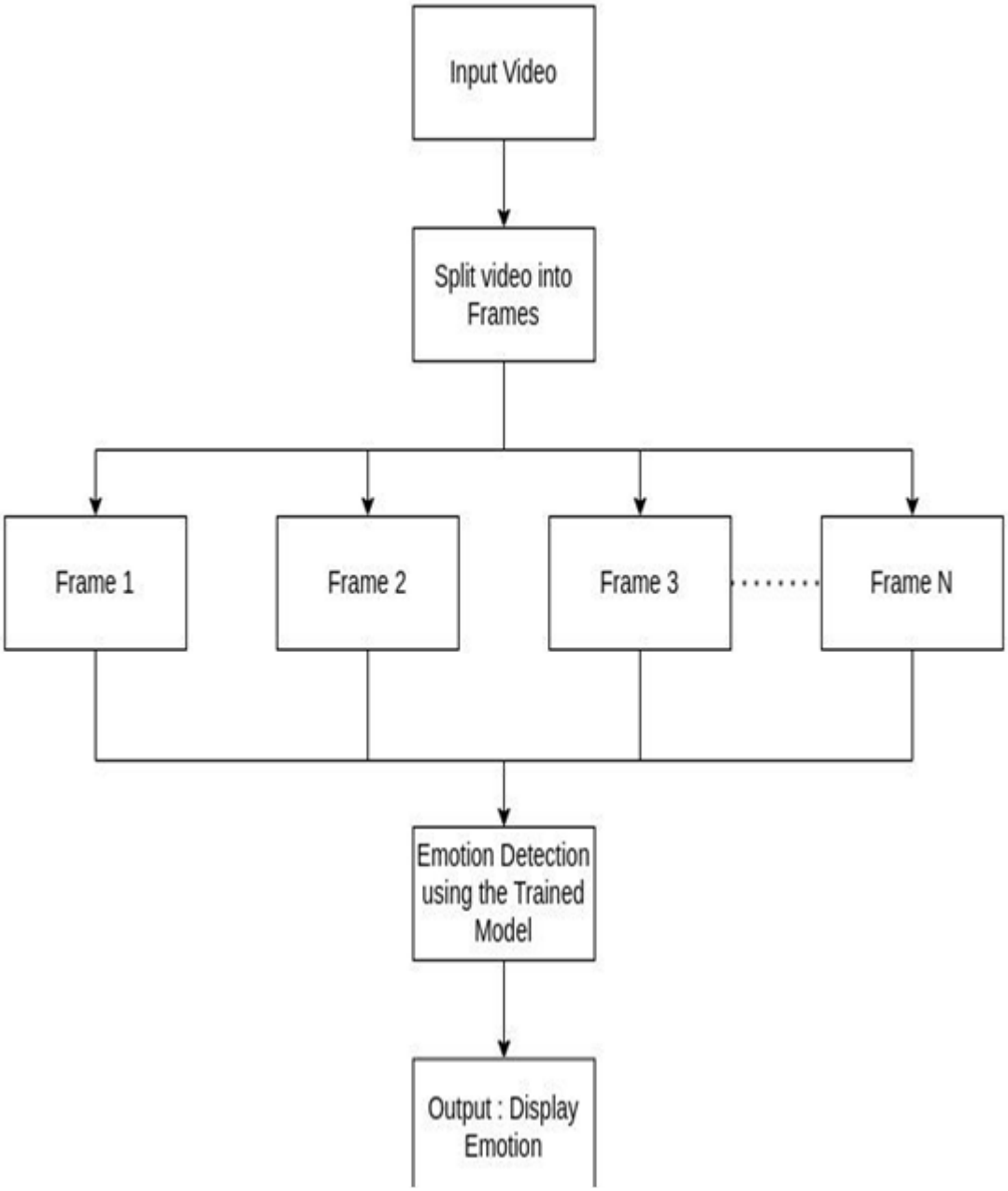

Figure 3: System design

Video is one of the major datasets in Affective Computing that are available, and lots of research is still ongoing to understand how to use them in emotion recognition. The input video is split into multiple frames. Each frame is then preprocessed, resized and sent to the trained model for emotion detection. The predicted output of the frames is then displayed on the screen.

SYSTEM REQUIREMENT SPECIFICATIONS

HARDWARE REQUIREMENTS:

RAM : Minimum 4GB

Processor : Any Intel or AMD x86-64 processor

Internet Connection: Required

SOFTWARE REQUIREMENTS:

Operating system : Windows 7 or More

Programming Language : Python

Dataset : Kaggle

Software : Google Colab / Jupiter

ABOUT DATASET

The dataset contains **35,685** examples of **48x48 pixel gray scale** images of faces divided into train and test dataset. Images are categorized based on the emotion shown in the facial expressions (happiness, neutral, sadness, anger, surprise, disgust, fear).

All the photos are divided as train and test data which is then passed through the model to detect emotion.

Figure 4 : Angry (Lowered and burrowed, eyebrowsIntense gaze, Raised chin)

Figure 5 : Disgust(Eyebrows pulled down, nose wrinkled, upper lip pulled up, lips loose)

Figure 6 : Happy(Raised corners of mouth into a smile)

Figure 7 : Sad(Furrowed brows, Lip corner depressor)

Figure 8 : Neutral

Figure 9 : Fear(Wide eyes, Furrowed brows)

Figure 10 : Surprise(Dropped jaw, Raised brows, Wide eyes)

EXPECTED OUTCOME

The expected outcome of the project is predicting the emotions such as sad, happy, anger, surprised, fear, disgust and neutral from the collected dataset and the model built for the emotion detection for real time application.

Face Detection and Extraction of expressions from facial images is useful in the healthcare industry such as observing the condition of the patient during treatment.

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