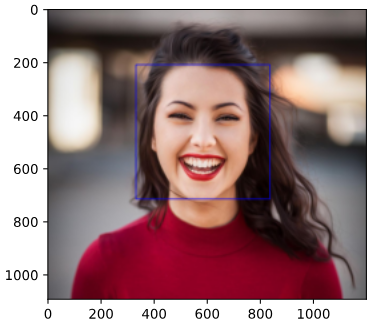
**CHAPTER 2**

**INTRODUCTION**

Understanding and interpreting emotions is a fundamental aspect of human interaction, encompassing both verbal and nonverbal cues. For individuals facing paralysis, who may encounter challenges in expressing emotions through conventional means, this project aims to employ artificial intelligence to decipher facial expressions. Recognizing the significance of emotions, with statistics indicating that they account for 66% of all communication, the project will focus on the six primary emotions: disgust, anger, fear, happiness, surprise, and sadness. Large datasets will be crucial for training the AI to decode facial expressions accurately, enhancing its ability to read and interpret emotional states. The ultimate goal is to develop a system that not only comprehends facial expressions in paralyzed individuals but also sends real-time notifications via email, ensuring timely communication of emotional states. This research holds particular importance in security domains, as facial reading serves as a primary means of identifying intentions. Moreover, the study of emotions spans various domains such as medical technology, psychology, neurology, and health, showcasing its broad impact. By extending this technology to airport security, where personnel rely on body language and facial expressions to detect potential criminal activity, the project aims to contribute significantly to enhancing communication and security measures for paralyzed individuals

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**ARTIFICIAL INTELLINGENCE:**

Artificial intelligence (AI) is the ability of a computer program or a machine to think and learn. It is also a field of study which tries to make computers "smart". As machines become increasingly capable, mental facilities once thought to require intelligence are removed from the definition. AI is an area of computer sciences that emphasizes the creation of intelligent machines that work and reacts like humans. Some of the activities computers with artificial intelligence are designed for include: Face recognition, Learning, Planning, Decision making etc.,

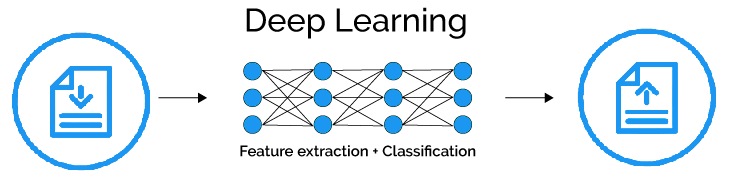
Artificial intelligence is the use of computer science programming to imitate human thought and action by analysing data and surroundings, solving or anticipating problems and learning or self-teaching to adapt to a variety of tasks.

* 1. **DEEP LEARNING**

A subset of machine learning techniques called "deep learning" is based on representation learning in artificial neural networks. The use of multiple layers in the network is indicated by the adjective "deep" in deep learning. The employed techniques can be unsupervised, semi-supervised, or supervised.

In a variety of fields, including computer vision, speech recognition, natural language processing, machine translation, bioinformatics, drug design, medical image analysis, climate science, material inspection, and board game programming, deep-learning architectures such as deep neural networks, deep belief networks, deep reinforcement learning, recurrent neural networks, convolutional neural networks, and transformers have produced results on par with, if not better than, human expert performance.

The information processing and distributed communication nodes found in biological systems served as the model for artificial neural networks, or ANNs. ANNs are not like biological brains in a number of ways. In particular, the biological brain of the majority of living things is dynamic (plastic) and analog, whereas artificial neural networks typically exhibit static and symbolic behavior. The below block diagram explains the working of Deep Learning algorithm:



* + 1. **Features of Deep Learning:**
* Deep learning systems can perform feature extraction automatically, meaning they don't require supervision to add new features.
* Deep learning systems can process both structured and unstructured data.
* Accuracy
* Deep learning systems can analyse large amounts of data and uncover complex patterns in images, text and audio and can derive insights that it might not have been trained on.
  + 1. **Classification of Deep Learning**

At a broad level, Deep learning can be classified into three types:

1. Supervised learning
2. Unsupervised learning
3. Partially Supervised (semi-supervised)

### 1) Supervised Learning

**Supervised learning is a type of machine learning where the algorithm is trained on a labeled dataset, which means that the input data is paired with the corresponding correct output. In other words, the algorithm is provided with input-output pairs, and the goal is to learn a mapping function from the input to the output.**

**In the context of deep learning, which is a subfield of machine learning, supervised learning involves using neural networks to learn complex mappings from inputs to outputs. These neural networks are composed of layers of interconnected nodes (neurons) that process the input data and produce an output. During the training process, the network adjusts its internal parameters (weights and biases) based on the difference between its predictions and the true outputs in the labeled training data.**

**The training process typically involves an optimization algorithm (e.g., gradient descent) that minimizes a loss function, which measures the difference between the predicted outputs and the true outputs. The goal is to find the optimal set of parameters that minimizes this loss, allowing the model to generalize well to new, unseen data.**

**Supervised learning in deep learning is widely used in various applications, such as image recognition, natural language processing, speech recognition, and many others. It is called "supervised" because the process involves a "teacher" (the labeled data) guiding the learning algorithm to make accurate predictions.**

### 2) Unsupervised Learning

Unsupervised learning is a type of machine learning where the algorithm is given input data without explicit instructions on what to do with it. Unlike supervised learning, there are no labeled outputs provided during training. The goal of unsupervised learning is to find patterns, relationships, or structures in the data without explicit guidance. In the context of deep learning, unsupervised learning encompasses various approaches, and common types are:

* **Clustering**
* **Dimensionality Reduction**
* **Generative Models**
  1. **GUI (Graphical User Interface)**

A Graphical User Interface (GUI) in Python refers to a visual way of interacting with a computer program. Instead of relying on text-based commands, GUIs utilize graphical elements such as windows, buttons, menus, and other visual components to enable user interaction. Python provides several libraries for creating GUI applications, with Tkinter being the default and widely used option. GUIs enhance user experience by offering an intuitive and visually appealing environment for interacting with software. Developers can design interfaces that make complex functionalities accessible to users through mouse clicks, keyboard input, or touch interactions, catering to a broad range of applications from desktop software to mobile apps. The design and implementation of GUIs in Python involve the use of specific libraries that simplify the creation and management of graphical elements, allowing developers to build interactive and user-friendly applications.

**LITERATURE SURVEY**

**[1] TITLE:** Facial emotion recognition using convolutional neural networks (FERC)

**AUTHOR:** Ninad Mehendale

**DESCRIPTION:**

Facial expression for emotion detection has always been an easy task for humans, but achieving the same task with a computer algorithm is quite challenging. With the recent advancement in computer vision and machine learning, it is possible to detect emotions from images. In this paper, we propose a novel technique called facial emotion recognition using convolutional neural networks (FERC). The FERC is based on two-part convolutional neural network (CNN): The first-part removes the background from the picture, and the second part concentrates on the facial feature vector extraction. In FERC model, expressional vector (EV) is used to find the five different types of regular facial expression. Supervisory data were obtained from the stored database of 10,000 images (154 persons). It was possible to correctly highlight the emotion with 96% accuracy, using a EV of length 24 values. The two-level CNN works in series, and the last layer of perceptron adjusts the weights and exponent values with each iteration. FERC differs from generally followed strategies with single-level CNN, hence improving the accuracy. Furthermore, a novel background removal procedure applied, before the generation of EV, avoids dealing with multiple problems that may occur (for example distance from the camera). FERC was extensively tested with more than 750K images using extended Cohn–Kanade expression, Caltech faces, CMU and NIST datasets. We expect the FERC emotion detection to be useful in many applications such as predictive learning of students, lie detectors, etc.

**[2] TITLE:** Facial Emotion Detection Using Deep Learning

**AUTHOR:** Akriti Jaiswal

**DESCRIPTION:**

Human Emotion detection from image is one of the most powerful and challenging research task in social communication. Deep learning (DL) based emotion detection gives performance better than traditional methods with image processing. This paper presents the design of an artificial intelligence (AI) system capable of emotion detection through facial expressions. It discusses about the procedure of emotion detection, which includes basically three main steps: face detection, features extraction, and emotion classification. This paper proposed a convolutional neural networks (CNN) based deep learning architecture for emotion detection from images. The performance of the proposed method is evaluated using two datasets Facial emotion recognition challenge (FERC-2013) and Japaness female facial emotion (JAFFE). The accuracies achieved with proposed model are 70.14 and 98.65 percentage for FERC-2013 and JAFFE datasets respectively.

**[3] TITLE:** Facial Expression Recognition using Convolutional Neural Network with Data Augmentation

**AUTHOR:** Tawsin Uddin Ahmed

**DESCRIPTION:**

Detecting emotion from facial expression has become an urgent need because of its immense applications in artificial intelligence such as human-computer collaboration, data-driven animation, human-robot communication etc. Since it is a demanding and interesting problem in computer vision, several works had been conducted regarding this topic. The objective of this research is to develop a facial expression recognition system based on convolutional neural network with data augmentation. This approach enables to classify seven basic emotions consist of angry, disgust, fear, happy, neutral, sad and surprise from image data. Convolutional neural network with data augmentation leads to higher validation accuracy than the other existing models (which is 96.24%) as well as helps to overcome their limitations.

**[4] TITLE:** Facial Emotion Recognition Using Transfer Learning in the Deep CNN

**AUTHOR:** Tetsuya Shimamura

**DESCRIPTION:**

Human facial emotion recognition (FER) has attracted the attention of the research community for its promising applications. Mapping different facial expressions to the respective emotional states are the main task in FER. The classical FER consists of two major steps: feature extraction and emotion recognition. Currently, the Deep Neural Networks, especially the Convolutional Neural Network (CNN), is widely used in FER by virtue of its inherent feature extraction mechanism from images. Several works have been reported on CNN with only a few layers to resolve FER problems. However, standard shallow CNNs with straightforward learning schemes have limited feature extraction capability to capture emotion information from high-resolution images. A notable drawback of the most existing methods is that they consider only the frontal images (i.e., ignore profile views for convenience), although the profile views taken from different angles are important for a practical FER system. For developing a highly accurate FER system, this study proposes a very Deep CNN (DCNN) modeling through Transfer Learning (TL) technique where a pre-trained DCNN model is adopted by replacing its dense upper layer(s) compatible with FER, and the model is fine-tuned with facial emotion data. A novel pipeline strategy is introduced, where the training of the dense layer(s) is followed by tuning each of the pre-trained DCNN blocks successively that has led to gradual improvement of the accuracy of FER to a higher level. The proposed FER system is verified on eight different pre-trained DCNN models (VGG-16, VGG-19, ResNet-18, ResNet-34, ResNet-50, ResNet-152, Inception-v3 and DenseNet-161) and well-known KDEF and JAFFE facial image datasets. FER is very challenging even for frontal views alone. FER on the KDEF dataset poses further challenges due to the diversity of images with different profile views together with frontal views. The proposed method achieved remarkable accuracy on both datasets with pre-trained models. On a 10-fold cross-validation way, the best achieved FER accuracies with DenseNet-161 on test sets of KDEF and JAFFE are 96.51% and 99.52%, respectively. The evaluation results reveal the superiority of the proposed FER system over the existing ones regarding emotion detection accuracy. Moreover, the achieved performance on the KDEF dataset with profile views is promising as it clearly demonstrates the required proficiency for real-life applications.

**[5] TITLE:** Deep learning-based facial emotion recognition for human–computer interaction applications

**AUTHOR:** M. Kalpana Chowdary

**DESCRIPTION:**

One of the most significant fields in the man–machine interface is emotion recognition using facial expressions. Some of the challenges in the emotion recognition area are facial accessories, non-uniform illuminations, pose variations, etc. Emotion detection using conventional approaches having the drawback of mutual optimization of feature extraction and classification. To overcome this problem, researchers are showing more attention toward deep learning techniques. Nowadays, deep-learning approaches are playing a major role in classification tasks. This paper deals with emotion recognition by using transfer learning approaches. In this work pre-trained networks of Resnet50, vgg19, Inception V3, and Mobile Net are used. The fully connected layers of the pre-trained ConvNets are eliminated, and we add our fully connected layers that are suitable for the number of instructions in our task. Finally, the newly added layers are only trainable to update the weights. The experiment was conducted by using the CK + database and achieved an average accuracy of 96% for emotion detection problems.