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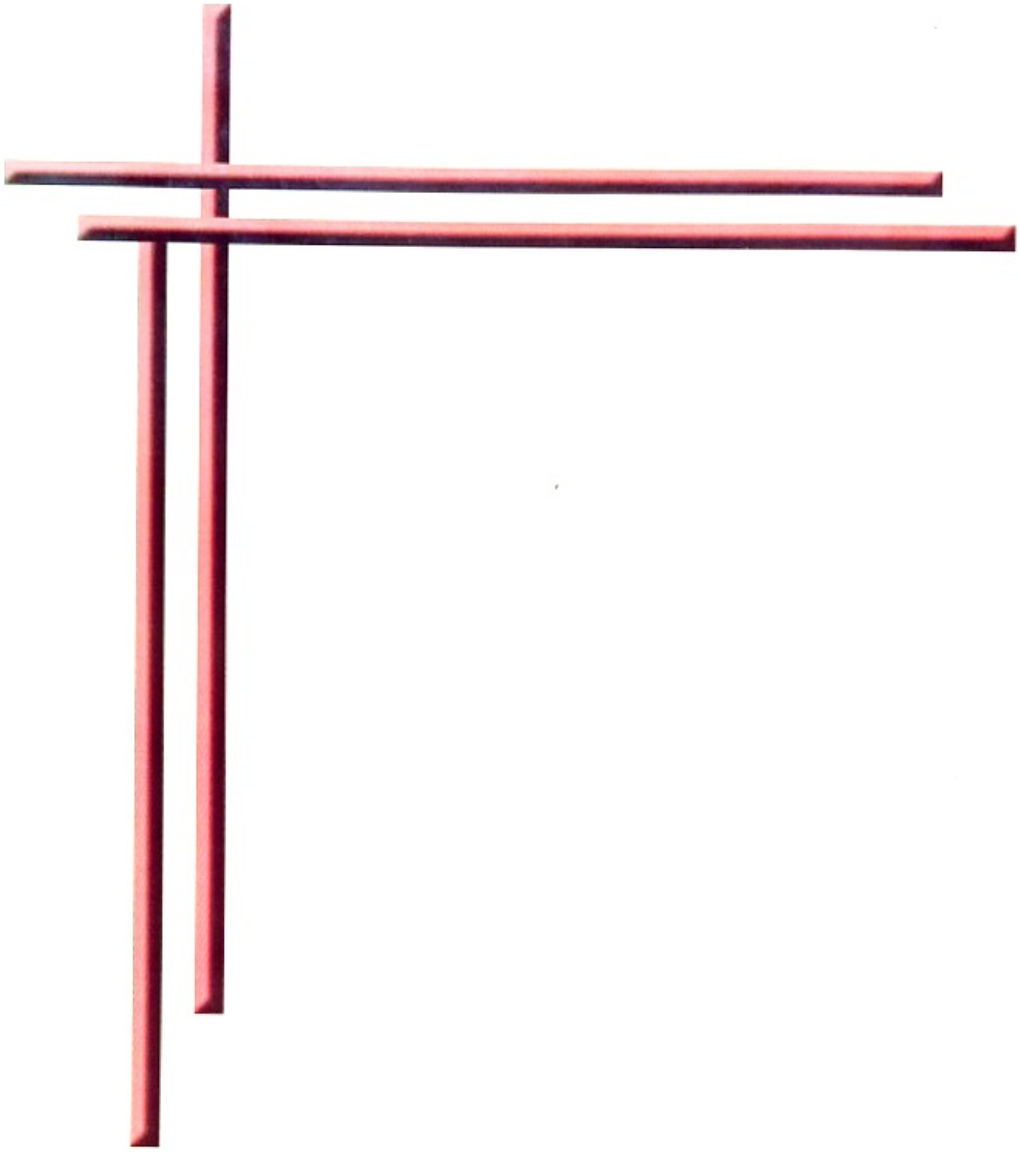

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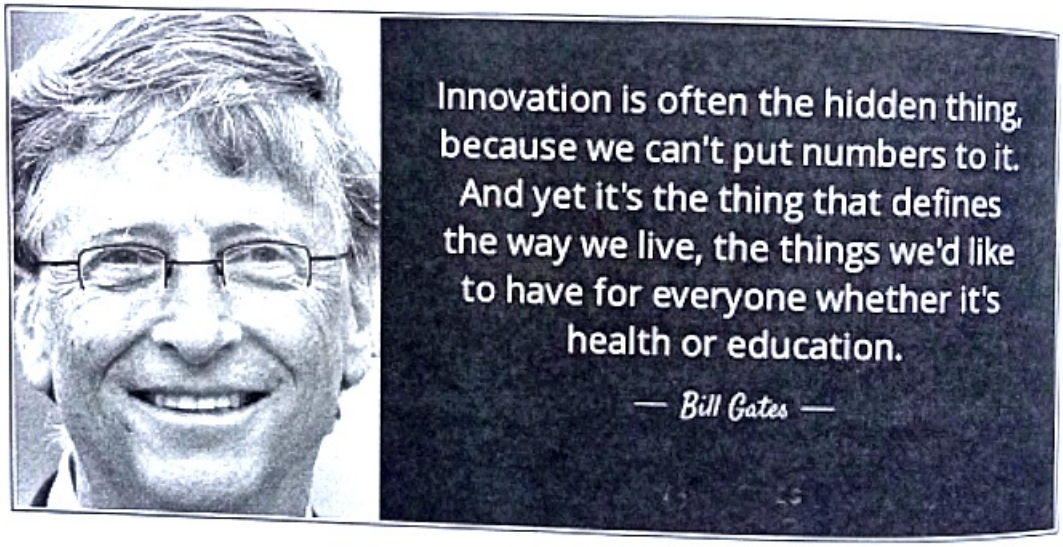
Innovation is often the hidden thing, because we can't put numbers to it. And yet it's the thing that defines the way we live, the things we'd like to have for everyone whether it's health or education.
— Bill Gates —

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Preface

This book "**Innovations in Education**" is a collaborative initiative by Sreekrishnapuram V.T. Bhattathiripad College, University of Calicut. This aims to comprise the research perspectives of E-teaching and E-Content development. Researchers are from different educational backgrounds and they all are here to express their innovative ideas. Now, there is a lot of researches going on in this area of E-teaching and E-Content development. This book aims at motivating beginners in E-teaching by introducing new methodologies, going through discussions about the impact of digital teaching in the higher education area, and also provides new insights about E-teaching and E-learning. It is the need of the present day scenario. We extend our sincere gratitude to all who stood along with us in this great venture. We congratulate all the authors for their contributions to this volume.

This book suggests some approaches that they can adopt to manage this sudden shift of teaching and learning from physical classrooms to digital classrooms. Even though the internet and all the E-teaching technologies are around us for a long time, we were hesitant of implementing these into our Teaching-Learning process. This book aims to walk along with the teachers and guides them to a new era of E-teaching.

We must thank our publisher Mr. Suresh Chandra Sharma, Managing Director of Neelkamal Publications Pvt. Ltd., New Delhi-Hyderabad, who has taken a lot of interest in this book. His efforts to bring out the Book in the excellent form will always be remembered.

We feel happy to entertain any suggestions and additions for refinements of this book and all such modifications will be taken care of in the next issue of the book.

Editors

Dr. Jayan Erancheri Illam
Dr. Saritha Namboodiri
Bhavya P.V.

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Thanks to everyone on our publishing team and our publishing partner Neelkamal Publications Pvt. Ltd., for their sincere cooperation.

The technical support given by EMMRC, University of Calicut for our teachers and contributors to the book in related to educational technology is highly appreciated. We express our sincere gratitude to the team EMMRC for this successful endeavour.

We are extending our gratitude to all the contributors of the book.

Thank all those who contributed to the success of the physical creation to completion of this book.

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INNOVATIONS IN EDUCATION

Contents

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CHAPTER

12

Facial Expression Recognition Using Convolution Neural Network for Adaptive Learning in MOOC

– Bhavya P.V.*
Aswathy A.**
Dr. Saritha Namboodiri***

ABSTRACT

Massive Open Online Course (MOOC) is most widely used online teaching method today. Fruitful teaching must accompany with reliable feedback system. The satisfaction level of learners while doing these courses is not much evaluated yet. Ongoing feedback system is based on questionnaires or reviews. MOOCs attract many learners from all over the world, so there is a need to enhance the MOOCs content to meet the individual needs. This paper proposes a method to evaluate satisfaction levels of learners from their facial expressions. This system captures facial image of the learner, while they attend the course. Using Convolution Neural Network (CNN), system recognizes the facial expression of learner. Analysis of facial expressions obtained at regular intervals of each lecture of different learners is recorded and evaluated. Adaptive learning is an emerging teaching method to improvise course content according to the performance of learner. MOOC can utilize this evaluation report for adaptive learning. Adaptive learning helps MOOC to reduce dropouts during the course.

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12.1 Introduction

Open online distance learning in higher education has quickly grown popularity with Massive Open Online Courses (MOOCs). New web technologies allow scalable ways to deliver video lecture content, implement social forums and track student progress in MOOCs. These courses are called 'massive', since there is no limit to the number of registered students/learners, and 'open', because the coursecontentis openly-licensed. They can be accessed online and they have a specific structure with a definite material to be studied.

This type of e-Learning system shows a considerable amount of difference than the traditional classroom style education because it enables learners to overcome the spatial, temporal and environmental limits. For example, MOOCs are available online at any time, regardless of the daily life hours, which implies that students can get access to all the course materials other than the official school hours. Not only can the learner retrieve readings, texts, and video contents, but also live forum based interaction from other students and instructors around the globe is made possible thanks to the assistance of the network, even solving the spatial limitation issue.

However, on the other hand, MOOCs are criticized for the low completion ratio. The completion ratio will be affected by many factors. In this paper we will analyze the effectiveness of MOOC lectures by analyzing the facial expressions while listening the videos. Facial expression detection method is an effective way to analyze the different understanding levels of person and also proposed a method to improve the lectures based on the results obtained after analysis.

Facial Expression Recognition is implemented using Mini_Xception CNN, Machine learning approach. Though there are methods to identify expressions using machine learning and artificial Intelligence techniques, this work attempts to use CNN and image classification method to recognize expressions and classify the expressions according to the images. Images of learners are captured when they attend the course. Images are then tested using CNN to recognize the expression. After taking images in a regular interval we can analyze the satisfaction level of learner. This approach helps to improve the quality of MOOC courses.

12.2 Literature Survey

MOOC courses are highly demanding and it helps to improve the knowledge levels of people in various areas of their interests. Recently, some

institutions have tried to balance this high level of demand using the MOOC, "Massive Open Online Course". This term was coined in 2008 by George Siemens and Stephen Downs after completing the online course CCK08[1].

The most important issues facing in both academic literature is the high rate of dropouts among MOOC learners. Even though large number of participants enroll on these courses, the completion rate for most courses is below 13%[2]. This paper analyses MOOC erosion based on several different attributes. Firstly, we analyze existing literature relating to MOOC dropout rates, together with existing outcomes on completion rates and analyses several specific courses, which identify factors that correlate to likelihood of dropout. The paper provides a meta-analysis of the basic figures on overall dropout rates previously collected to identify relationships between course factors and dropout rates. Moreover, the literature is reviewed from qualitative views together with the findings on the reasons for dropout and ways suggested for resolving or reducing the dropout rate. Secondly, using themes emerging from the initial investigation, the paper provide a preliminary analysis of data gathered from a Computing MOOC run by the University of Warwick, UK and presented using a Moodle platform. The results indicate that many learners who may be categorized as dropouts are still participating in the course in their own preferred way. This suggests that the structure of "a course" may not be helpful to all learners and supporting different patterns of engagement and presentation of material may be beneficial.

There are numerous areas in human–computer interaction that could beneficially use the capability to understand expression. Most of them are based on facial expression recognition and speech signal analysis[3]. Another possible approach for expression recognition is physiological signal analysis[4]. In this area,traditional tools for the research of human emotional status are based on the recording and statistical analysis of physiological signals from both the central and autonomic nervous systems[5].

Researchers at IBM recently reported an emotion recognition device based on mouse-type hardware[6]. Eventhough they illustrated the possiblility of a physiological signal-based emotion recognition system, several aspects of its performance need to be improved before it can be utilized as a practical system. First, their algorithm development and performance tests were carried out by using data that reflect deliberately expressed emotion.

Moreover, their data were acquired from only one subject, and, hence, their emotion recognition algorithmis user-dependent and must be tuned to a

specific person. It is normal to begin from the development of a user-dependent system, as the speech recognition system began with a speaker-dependent system. Nevertheless, a user-independent system is necessary for practical application, so that the users do not have to be considered with training of the system. According to our knowledge, there is no previous study that has demonstrated a physiological signal-based emotion recognition system that is applicable to multiple users.

Another problem with current systems is the required length of signals. At present, at least 2–5 min of signal monitoring is required for a decision. For practical purposes, the required monitoring time should be limited further.

The system contains different stages which includes characteristic waveform detection, feature extraction and pattern classification . Although the waveform detection and feature extraction stages were designed carefully, there was a large amount of within-class variation of features and overlap between classes. This problem could not be solved by simple classifiers, such as linear and quadratic classifiers, that were adopted for previous studies with similar purposes.

Deep learning in neural networks has wide applications in the area of image recognition, classification, decision making, pattern recognition etc[7]. Though there are methods to identify expressions using machine learning and Artificial Intelligence techniques, this work attempts to use deep learning and image classification method to recognize expressions and classify the expressions according to the images. Various datasets are investigated and explored for training expression recognition model are explained in this paper. Inception Net is used for expression recognition with Kaggle (Facial Expression Recognition Challenge) and Karolinska Directed Emotional Faces datasets. Final accuracy of this expression recognition model using Inception Net v3 Model is 35%(~).

12.3 System Architecture

The Architecture is divided into three modules. First module divides a lecture into 4 quarters and images are captured at regular intervals (Fig.12.1). In the next module captured images are tested using CNN to recognize expression Fig.12.2. All facial expressions at regular intervals are analyzed (Fig.12.3) to get review about the lecture.

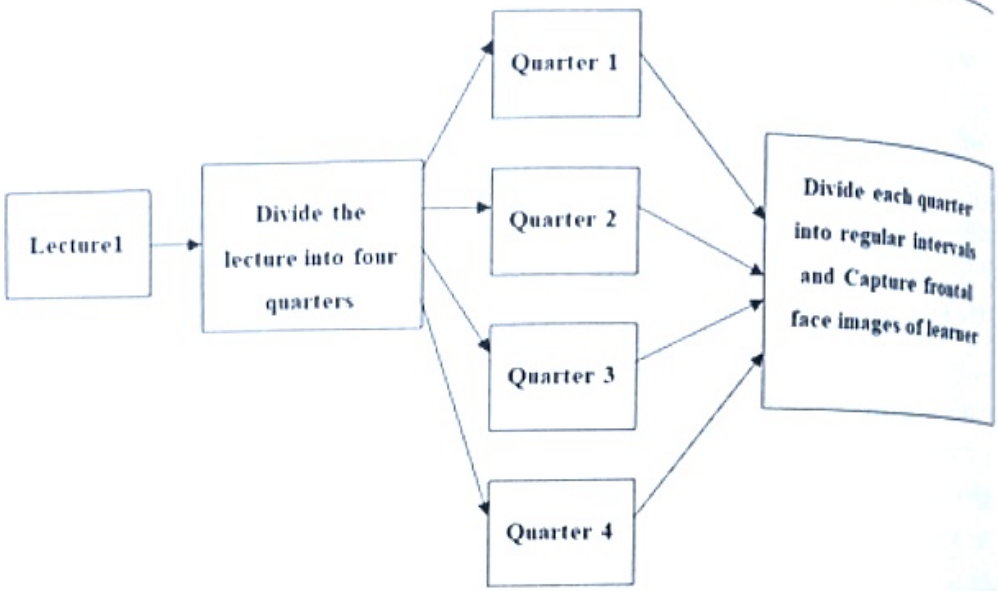

Figure-12.1: Sampling of Each Lecture into Four Quarters

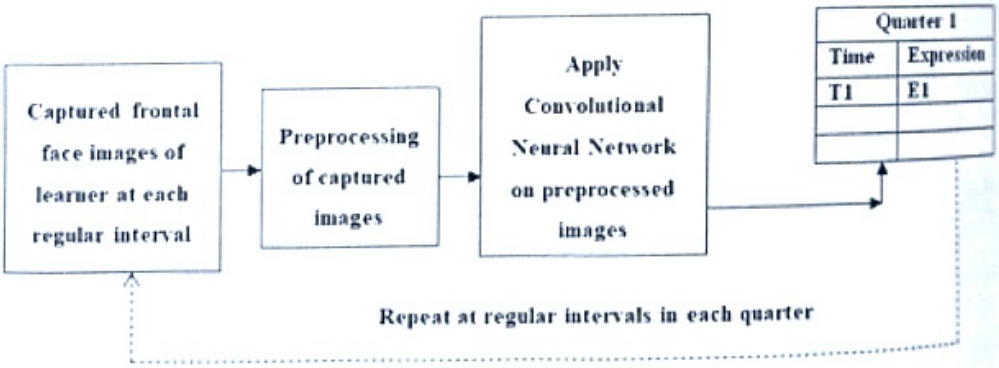

Figure-12.2: Facial Expression Recognition

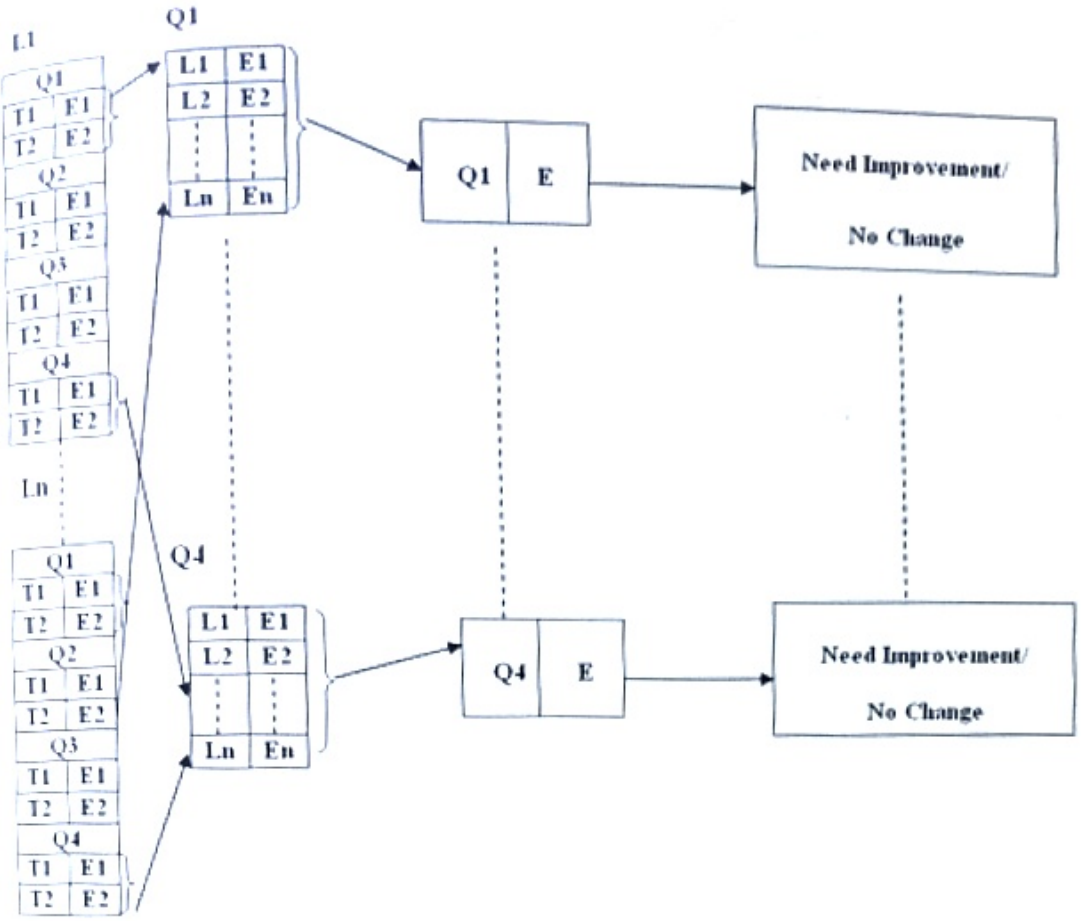

Figure-12.3: Analysis of Expression

The overall system architecture divided into three phases:

i) Dividing each lecture into four quarters

ii) Facial Expression Recognition

iii) Analysis of Expression

i) Dividing each Lecture into Four Quarters

Initially, for each lecture, total duration of the video is splitted into four equal quarters. Each quarter again split at regular intervals.The system capture facial images of learners during these small periods using web cam while listening to a lecture.

ii) Facial Expression Recognition

In this phase, system tries to understand the expression of learners while watching a lecture. After collecting images for each quarter, system preprocess these images. Using techniques of Convolutional Neural Network (CNN) the expression of learners for each time period will be obtained.

iii) Analysis of Expression

This phase analyze the expressions of four quarters to find whether need a modification in a lecture. Expression for each quarter obtained by analyzing the images within the intervals in each quarter. For each quarter, for example, for quarter1(Q1) compare the expressions(E1) of n learners and evaluate the expression for quarter1.Similarlly, find expressions for four quarters. Based on these expressions, find whether an improvement need for particular quarter. Then by comparing expressions for four quarters of each lecture find the feedback for the whole lecture. If there is an improvement needed in at least one quarter then report a modification for particular lecture. Otherwise no change needed.

Based on these feedbacks we can easily understand the area which need improvement and can make appropriate changes to make the lecture better.

12.4 System Implementation Using CNN

12.4.1 Dataset

Facial expression recognition (FER) data-set from Kaggle challenge is downloaded . The data consists of 48×48 pixel grey scale images of faces. The faces have been automatically registered so that the face is more or less centered and occupies about the same amount of space in each image. The task is to categorize each face based on the emotion shown in the facial expression in to one of two categories (0=Not Clear, 1= Clear).

The training set consists of 35,888 examples. train.csv contains two columns, "expression" and "pixels". The "expression" column contains a numeric code 0 or 1 inclusive, for the expression that is present in the image. The "pixels" column contains a string surrounded in quotes for each image. The contents of this string a space-separated pixel values in row major order.

Loading Dataset

First the code loads the data-set and pre-processes the images for feeding it to CNN model. There are two functions in the code snippet:

1. **def load_fer2013**: It reads the csv file and convert pixel sequence of each row in image of dimension 48*48. It returns faces and expression labels.
2. **defpreprocess_input**: It is a standard way to pre-process images by scaling them between -1 to 1. Images is scaled to [0,1] by dividing it by 255. Further, subtraction by 0.5 and multiplication by 2 changes the

range to [-1,1]. [-1,1] has been found a better range for neural network models in computer vision problems.

12.4.2 Convolution Neural Network

Training CNN Model: Mini Xception

A new architecture which is comparatively small and achieves almost state-of-art performance of classifying emotion on this data-set. The below architecture was proposed by Octavio Arragia et al.

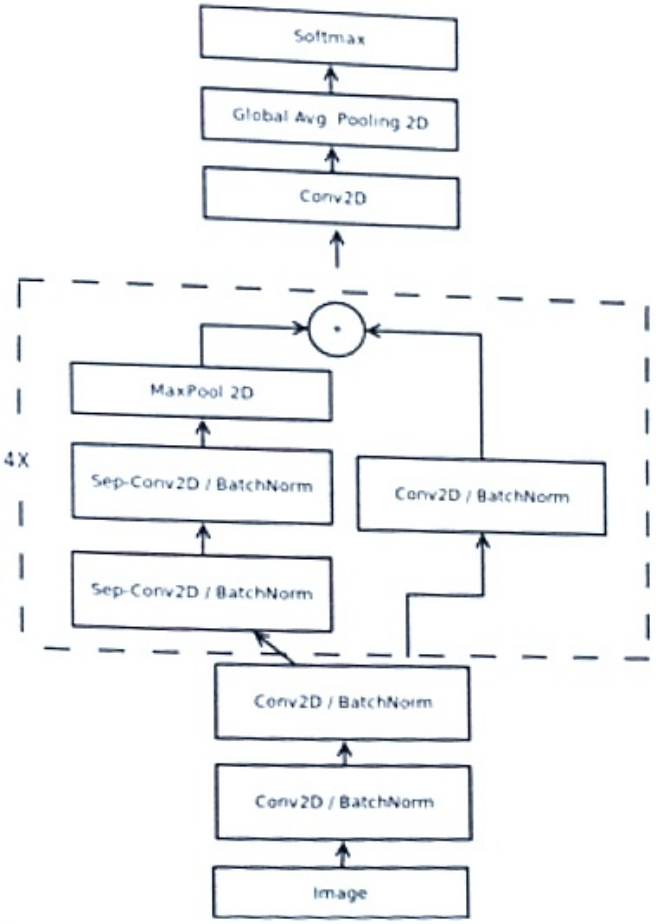

Figure-12.4: Proposed Mini_Xception Architecture for Emotion Classification

The center block of the architecture is repeated 4 times in the design. This architecture is different from the most common CNN architecture. Common architectures uses fully connected layers at the end where most of parameters resides. Also, they use standard convolutions. Modern CNN architectures such as Xception leverage from the combination of two of the most successful experimental assumptions in CNNs: the use of residual modules and depth-wise separable convolutions.

There are various techniques that can be kept in mind while building a deep neural network and is applicable in most of the computer vision problems. Below are few of those techniques which are used while training the CNN model below.

- **Data Augmentation**: More data is generated using the training set by applying transformations. It is essential if the training set is not sufficient enough to learn representation. The image data is produced by transforming the actual training images by rotation, crop, shifts, shear, zoom, flip, reflection, normalization etc.
- **Kernel_regularizer**: It permits to apply penalties on layer parameters during optimization. These penalties are combined in the loss function that the network optimizes. Argument in convolution layer is nothing but L2 regularisation of the weights. This penalizes peaky weights and makes certain that all the inputs are considered.
- **BatchNormalization**: It normalizes the activation of the previous layer at each batch, i.e. applies a transformation that maintains the mean activation close to 0 and the activation standard deviation close to 1. It reports the problem of internal covariate shift. It also acts as a regularizer, in some cases eliminating the need for Dropout. It helps in speeding up the training process.
- **Global Average Pooling**: It reduces each feature map into a scalar value by taking the average over all elements in the feature map. The average operation forces the network to extract global features from the input image.
- **Depthwise Separable Convolution**: These convolutions are composed of two different layers: depth-wise convolutions and point-wise convolutions. Depth-wise separable convolutions reduces the computation with respect to the standard convolutions by reducing the number of parameters.

12.4.3 Testing and Evaluation

While performing tests on the trained model, it was observed that model detects the expression of faces as neutral if the expressions are not made distinguishable enough. The model gives probabilities of each expression class in the output layer of trained mini_xception CNN model. Test the model using a test data captured using webcam. Record the result in each interval. Summarize the report for evaluation.

12.4.4 Analysis

Capture images of different learners while learning a particular course. Record the output as table consists of time and expression. Compare and analyze the expression of different learners at the same time in the same video lecture to get an analysis report. Set a threshold value for analysis. If majority of expressions are positive or above certain threshold value,there is no need of improvement otherwise the lecture at that particular time need improvement.

12.5 Results

Figure-12.5(a) **Figure-12.5(b)**

Results show the learner is clear or not clear with the video content. Figure 12.5(a) shows that learner is not satisfied with content of lecture at that time. Figure 12.5(b) shows that learner is satisfied with the video content at that time.

12.6 Conclusion and Future Work

This project is an attempt to introduce adaptive learning in MOOC platform. System uses Mini_Xception architecture for expression classification. Expressions are the exact reflection of understanding level of learner.In future this system can be implemented as real time feedback system. Also the same CNN architecture can be trained using different datasets.

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