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ADAPTIVE MULTIMEDIA LEARNING FRAMEWORK WITH FACIAL RECOGNITION SYSTEM

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CERTIFICATION

This is to certify that the thesis titled **Adaptive Multimedia Learning Framework with Facial Recognition System** submitted to the school of postgraduate studies, African University of Science and Technology (AUST), Abuja, Nigeria for the award of the Master's degree is a record of original research carried out by **Ismaila Lukman Enegi (40526)** in the Department of Computer Science

TITLE OF THESIS
ADAPTIVE MULTIMEDIA LEARNING FRAMEWORK WITH FACIAL RECOGNITION SYSTEM

By

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DEDICATION

I dedicate this entire research work to **Allah** (Azzawajal) for granting me the opportunity, wisdom and strength to take this work to completion *Alhamdulillah*.

ACKNOWLEDGMENT

In the name of Allah the Most Gracious, the Most Merciful. All thanks are to Allah, the Cherisher and Sustainer for His all-encompassing mercy, protection, and guidance (Alhamdulillah).

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ABSTRACT

Recent breakthrough in mobile technology, wireless communication and sensing ability of smart devices promote the ease to detect real-world learning status of students as well as the context aware for learning. Targeted information can be provided to individual students in the right place and at the right time. This work is one of the three major modules of our Smart Learning Framework, others include Multimedia Module Contents (MMC) and Learning Style Index (LSI). However, this module of our work aimed to perfect efforts to correctly make decision during an academic learning process. This was based on the fact that adaptive decisions can be made to protect learner enthusiasm, promote learning grid and enhances general understanding of an adaptive learning environment if users immediate behavior and concern is well considered. This approach implements facial expression recognition on a smart phone (android) using effective SDK. This enables correct detection of facial expression for further understanding of the meaning in a learning environment. The output of this module is used for learners Behavior Analysis which then provide result of general evaluation of individual learner.

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Definition of terms

Acronyms

- **AI:** Artificial Intelligence.
- **CC:** Cognitive Computing
- **MLO:** Multimedia Learning Object
- **VLO:** Video Learning Object
- **AAM:** Active Appearance Model
- **CNN:** Convolutional Neural Network
- **LDA:** Linear Discriminant Analysis
- **SVL:** Support Vector Machine
- **FEAR:** Facial Expression Analysis & Recognition
- **ICIA:** Inverse Compositional Image Alignment
- **SDK:** Software Development Kit
- **API:** Application Programming Interface
- **UML:** Unified Modeling Language
- **FACS:** Facial Action Coding System
- **AU:** Action Unites

Keywords
Active Appearance Model, Adaptive Learning framework, Smart Learning Environment, Multimedia Learning facilities, Facial Expression Recognition, Deep learning

CHAPTER ONE

Introduction

This chapter discuss the fundamental aspects of this work. Our motivation, objectives and limitation were clearly described for easy understanding.

1.1 Background Introduction

An Adaptive learning system is an academic environment for teaching, learning, managing courses, and storing user data which helps in better understanding of the user learning behavior and preferences. More importantly, it applies users data to adapt various visible aspects of the system to the user. Adaptive learning systems tailor learners experience to suit individual needs. Adaptive learning frameworks provide an environment where adaptation and customization are achieved in order to improve the learning process. Generally, adaptive learning framework extends the benefits derived from traditional Learning Management Systems (LMS), and incorporates the idea of offering learners personalized support in a distance learning setting.

1.2 Cognitive Computing and Computer Vision

Cognitive computing (CC) describes technology platforms that, broadly speaking, are based on the scientific disciplines of Artificial Intelligence (AI) and image & signal processing. These platforms encompass machine learning, reasoning, natural language processing, speech and vision recognition (Object Recognition), human-computer interaction. Computer Vision (CV) is an interdisciplinary field that deals with how computers can be made for gaining high-level understanding from digital images or videos. Computer vision tasks include methods for acquiring, processing, analyzing and understanding digital images, and extraction of high-dimensional data from the real world in order to produce numerical or symbolic information

1.2.1 Human Facial Communication

In human-to-human conversation, communication involves both verbal, or spoken, and nonverbal, or unspoken, ways of making sure our message is passed from one person to another. When communicating nonverbally with others, we often use facial expressions, which are subtle signals of the larger communication process. Facial expressions include smiling, frowning, eye rolling, making eye contact, scowling etc. in order to pass a nonverbal message (Vasani et al., 2013).

1.2.2 Facial Image Recognition

The importance of facial expression system is widely recognized in social interaction and social intelligence. The system analysis has been an active research topic since 19th century. The facial expression recognition system was introduced in 1978 by Suwa *et al* . The main issue of building a facial expression recognition system is face detection and alignment, image normalization, feature extraction, and classification. There are number of techniques which we use for recognizing the facial expression which includes Template matching, Appearance-based methods like Eigenface-based Active appearance model etc.

1.2.3 Platform

Facial expression systems are often design to work in embedded computers, with recent development in technology, smart phones can now analyses images and understand the expression in them within a reasonably short time. Several image recognition systems exist in desktop platforms but more interestingly, our focus in this research effort is to implement facial expression recognition in mobile smart phone.

Security Concern in Image Recognition System (IRS) In today's world of growing technology, security of data is of major concern. Basically, attack of IRS is least discusses where there is no need to transfer information over the network. But necessary measure to avoid attack of any form are well considered and better solution is expected as there is active research on this area.

1.2.4 Problems/Challenges of Image Recognition

Image recognition generally face a number of problems in implementation, some of these issues as discussed by other researchers are broadly computer resources (memory), speed, accuracy, hard coded solution (non-generic) etc.

1.3 Statement of the Research Problem

An Adaptive learning framework needs to make decisions by considering not only what a user input or click but also should identify how a user feels about the learning process. In order to effectively achieve this, we intend to recognize a human face using the front camera of a mobile phone and extract the expression on the face. this can help the smart learning system make more effective decision in order to ensure effective learning is not jeopardized.

1.4 Aim and Objectives of the Research

The aim of this research is to design an optimized facial expression recognition application for android smart phone.

① To provide adaptive support to learners through immediate evaluation

② To Protect learners Enthusiasm

③ To provide personalize feedback to learners

1.5 Justification

The success story of mobile technology has made it possible to extract important facial image features for expression recognition in real time. Considering the portability, our system aim to exploit a handful of advantages provided by recent mobile tech-success speed, resource just to name a few.

1.6 Scope of Work

This work is focused on designing effective facial expression recognition on smart mobile phone. Six (6) expressions namely: joy, sad, disgust, angry, fear, surprise are recognized by the system. This module is directed to cover the adaptive learning processes of a student by making adaptive decisions base on the recognized learners facial expression. In view of this, the mobile application captures the facial image of a learner for extraction, it then analyze to see what expression is shown in the facial image. This process ensures an efficient conditional decision making scenario during learning called adaptive learning.

1.7 Summary

In this chapter, we provided a general introduction of what this research effort is all about. We explain the relevance of human emotion communication, security concern and current issues of facial expression recognition. Our direct concern in this study is to design an improved facial recognition system in smart phones. In view of this, a system model has been proposed and detail explanation of how the research problem was design and implemented are available in next chapters.

CHAPTER TWO

Literature Review

This chapter discusses several proposed Adaptive learning framework that exist so far. This is necessary in order to ensure efficiency in learning process, it is necessary to consider learners' facial expression as it is often considered as a powerful means of communication . In this chapter, we discussed some of the research efforts by different researchers, this is organized into the concepts that interest this research.

2.1 Research Background

In this research work, we have conducted a background review of other research work by different authors using conceptual approach. This is to ensure comprehensive understanding of various aspect of our work.

2.1.1 Adaptive Learning Framework

M. Leontidis *et al.* carried out studies on multimedia learning framework and proposed a learning software (MENTOR). They claimed that it adaptively provides learners with personalized and friendly multimedia learning environment based on their mood and emotions which build the positive learner attitude (Leontidis et al., 2011) . We consider this work relevant to our main goal which is to explore the impact of adaptive learning frameworks in the learning process which was investigated by T. Leacock *et al.* . Their work enable user create review with helps in learning goal alignment in order to ensure learners individual satisfaction (Leacock and Nesbit, 2007). Davenport *et al.* proposed a concept-based cognitive theory of multimedia learning which involves conceptual working memory component which shows that effectiveness of illustration in learning depend on the previous knowledge of the learner as well as conceptual information available in presentation (Davenport et al., 2008). S A Imran *et al.* proposes Multimedia Learning Object (MLO) for monitoring users effective learning and helps create

interactive MLOs in distance and blended education (Imran and Cheikh, 2012). Their work can be considered outstanding owing to the novel technique of developing video leaning objects (VLOs). Faisal *et al.* suggested a personalize and adaptive e-learning system using crowd-sourcing and recommender systems. Their study considers learning style and learning preference in helping learners gain maximum satisfaction (Faisal et al., 2015). Similar to the work of Faisal *et al.* is N. Soonthornphisaj *et al.* who proposed the global e-learning framework as web service which can aggregate the recommended materials from other e-learning web sites and predicts more suitable materials to learners (Soonthornphisaj et al., 2006). Using a slightly different approach, C. Yu *et al.* propose an adaptive learning framework which allows agents interact with each other using basic learning (particularly reinforcement learning) methods agents can dynamically adapt their learning behaviors through social learning of their individual learning experience (Yu et al., 2016) .

2.1.2 Facial Image Recognition

Chitta K. *et al.* conducted experiments to classify facial images using reduced region of interest and discriminative salient patched on the face while reducing the required number of steps for their localization (Chitta and Sajjan, 2017). Singh K. A. *et al.* proposed a half-way face recognition approach. They verified their argurement that half faces are also sufficient in recognizing a facial feature by applying Principal Component Analysis (PCA)on both the full faces and half faces, and found similar accuracy result in both cases Singh and Nandi (2012). The approach of Ren C. *et al.* address a common issues with facial images recognition which involves matching Low Resolution (LR) and High Resolution (HR) images that poses challenges to conventional methods in practice due to the lack of efficient similarity measure(Ren, 2011). Salmam F. Z. *et al.* explore a new approach of facial expression recognition from image sequences, based on calculating six distances from eleven points of the face detected and tracked using unsupervised decent method which refer to the four internal part of the face and finally, he uses two data mining technique to classify facial expression into emotions (Salmam et al., 2017).

2.1.3 Facial Expression Recognition

Dhavalikar S. A *et al.* proposed an Automatic Facial Expression Recognition System (AFERS). The proposed method has three stages: (a) face detection, (b) feature extraction and (c) facial expression recognition. they explored lighting compensation for getting uniformity on face and morphological operations for preserving area of interest in the face. The result of the first stage is further utilized for extracting facial features like eyes, nose, and mouth using AAM (Active Appearance Model) method. The third stage, automatic facial expression recognition, involves simple Euclidean

Distance method (Dhavalikar and Kulkarni, 2014). The approach of real-time facial expression recognition is important for our work in order to ensure better efficiency in different situations. This idea was implemented using active appearance model trained to track one person's face to get very accurate shapes of the faces of the person on the input image frames with the processing speed of 11 frames/second (Choi and Oh, 2006a). The impact of using convolutional neural network for facial expression recognition was also demonstrated in the work of A. Raghuvanshi who classified images of human faces into discrete emotion categories and other architectures and methods like fractional max-pooling and fine tuning show good results when tested (Raghuvanshi and Choksi, 2016). Similar to this approach is the work of Mayya V. *et al.* who proposed a model for recognizing the facial expressions of an individual from a single image with reduced feature extraction time due to the use of general purpose graphical processing unit (Mayya et al., 2016). Shan K. *et al.* employ a deep Convolutional neural network (CNN) to develop a facial expression recognition system, which is capable of recognizing deeper feature representation of facial expression to achieve automatic recognition (Shan et al., 2017). These approaches are interestingly similar and useful to our exploration because of the intended mobile inclination.

2.1.4 Active Appearance Model

Martins P. *et al.* combines Active Appearance model (AAM) and Linear Discriminant Analysis (LDA). This was done by using AAM model to describe the human face, projecting the appearance results to a Fisher space using LDA to emphasize the different expression categories, and the performed classification is based on malahanobis distance (Martins et al., 2008) . Wilfred O. *et al.* also uses malahanobis distance to classify facial image into best fit class after vital feature on the facial components have been extracted using AAM from the facial region detected (Wilfred et al., 2009). Langford E. *et al.* proposed three classification techniques using Active appearance model a) Euclidean distance measure b) Gaussian Mixture Model c) Support Vector Machine (Langford et al., 2010). This is well related to the work of Martins P. *et al.* who proposed techniques to analyze face models with respect to facial expression analysis and head pose estimation. It is composed by three main modules, the AAM, the Facial Expression Analysis and Recognition (FEAR) and the Monocular Head Pose Estimation (Martins, 2008). The work of Cootes T. F. investigate the relationship between model parameter displacements and the residual errors induced between a training image and a synthesized model example, this yield a good overall match in a few iterations even from poor starting estimates (Cootes et al., 1998). Martins P. *et al.* result of AAM on edge images provide good results in varying lightening conditions. Additionally, three different facial expression classifiers (AAM classifier set, MLP and SVM) are compared with each other (Martin et al., 2008) .

2.1.5 Facial Recognition in Smart-phones

Choi H. C.*et al.* presents new technique on how illumination variation which occur in the mobile environment can be overcome. He discovered that the Difference of Gaussian (DoG) kernel preceded the AAM stage is very effective in tracking human face including important facial features such as eyes, nose and mouth, despite a strong directional illumination (Choi and Oh, 2006b). The Inverse Compositional Image alignment (ICIA) method has been developed to reduce the computing time for such image alignment task which makes it possible to track the face even in a real-time basis. Song K. I *et al.* explore deep neural network for facial expression recognition in smart phones. The deep convolutional neural network trained on a GPU has shown superior performance for various face datasets compared to a classifier based on hand-crafted features(Song et al., 2014). A technique called dropout combined with data augmentation was also proposed for combating outfitting. Sudha V. *et al.* present an facial expression recognition framework implemented in mobile phone with effective solution to lightening variation, head pose, expression user/device movement and computational complexity a bulk of this was achieved using personalize facial points tracking algorithm (Sudha et al., 2015). Alshamsi H. *et al.* proposed a novel real-time automatic system to recognize emotions from face images on a smart-phone in real-time. This is done by using the camera of the smart phone to capture the face image, BRIEF features are extracted and K-nearest neighbor algorithm is implemented for the classification (Alshamsi and Meng, 2016).

2.2 Research Gap and Proposed System

Adaptive learning frameworks and smart learning environment generally evaluate learners behavior through questions or other method of information acquisition to evaluate learners desire. This work is geared to exploit available technology. Hence, human non-verbal communication medium is considered effective and understandable using smart phone image recognition. This new direction of adaptive decision making from detected facial expression is interesting and we wish to explore its relevance.

2.3 Summary

In conclusion, the above reviewed work generally focused on various facial emotion recognition techniques. This approach is necessary for the effectiveness of our work. The above various concepts were considered in order to give us an overview understanding and relationship between the system we propose and other similar approaches in the field.

CHAPTER THREE

Research Design And Methodology

In this chapter, we discuss the general methodology adapted in carrying out this research work as well as the system analysis that assisted in achieving the project design.

We adopted Agile methodology through the processes of requirement analysis, system analysis, System design, implementation, results analysis & testing in other to evaluate the accuracy and effectiveness of our facial recognition software as well as the relevance of adaptive decision making using facial expression of learners. Important system developmental tools have also been highlighted so as to ensure better understanding.

3.1 System Feasibility Studies

In this project, we evaluated the possibility of the research work with our available resources and provided answer to important questions like computer resource, platform, speed, data-set and our software requirements.

Platform Implementation of this project is on smart phone powered with Android Operating System.

Image Data-set Essential images required to train our model after facial features have been marked was difficult until our conclusion to use Effectiva facial recognition SDK for Android implementation, although AAM tool was actively explored.

Speed Although processing power of smart phones have improved in recent years, different algorithms have various effect on speed of image recognition. In this work, we have chosen an SDK with good facial recognition ability and speed for implementation.

Computer Resources Generally, necessary confirmation needed to save computer resources is important to avoid out of memory exception during software run-time.

3.2 Requirement Analysis

Major Requirements of this research includes, Facial Images for feature marking and Android development environment (Android Studio) with Java Installation and configuration.

Minimum System Requirements

1. **Android Phone**
    - **SDK Version** 16 API or above & java 1.7 above
    - **RAM Memory** 1GB and above
    - **Memory Disk** 1GB and above
2. **Processor, Quad-core 1.5 GHz Cortex-A53**
3. **Camera** front or Rear
4. **Android Studio 2.x**

3.3 System Analysis and Research Approach

This project explore various concepts in previous research work in the field of image recognition and emotion understanding, we explore this approach to achieve the project objectives

3.4 Image Recognition Technique for Facial Expression

- **Face Detection:** This is a computer vision technique which involves all the process of identifying human face in a digital image or video.
- **Image Pre-Processing:** Pre-processing refers to the operation with images at the lowest level of abstraction. This is done to image data that suppresses unwilling distortions for further enhancement.

- **Principal Component Analysis (PCA):** This is a statistical image analysis method under factor analysis for image recognition and compression.
- **Image Classification:** Image classification refers to the task of extracting information classes from a multiband raster image
- **Emotion Recognition:** This involves the identification of a facial expression (emotion).

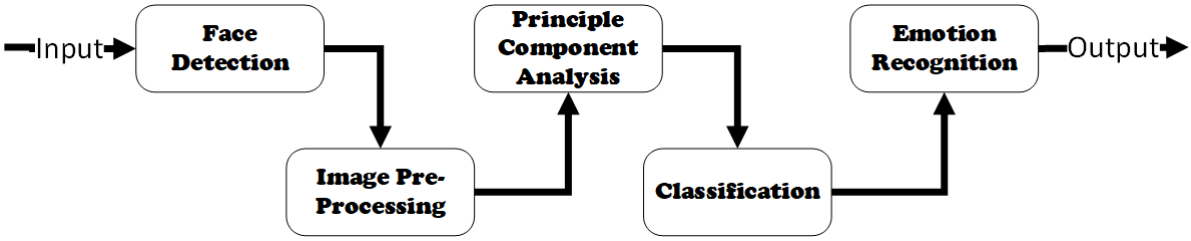


Figure 3.1: Basic Process of Facial Expression Recognition (Vasani et al., 2013)

3.5 System Diagrams

To ensure efficient capture of different aspects of this research work, some relevant UML diagrams were designed clearly explain some important relationships between different components of our system. These diagrams are designed under the guidance of our proposed algorithm.

3.5.1 System Model

The project model provides an overview of the overall system showing how the general structure are interlinked. Figure 3.2 shows a model of an Adaptive learning framework with highlight on facial expression recognition which is our major focus in this work. In this project, we implemented an android SDK for facial expression recognition which helps in the adaptive decision making.

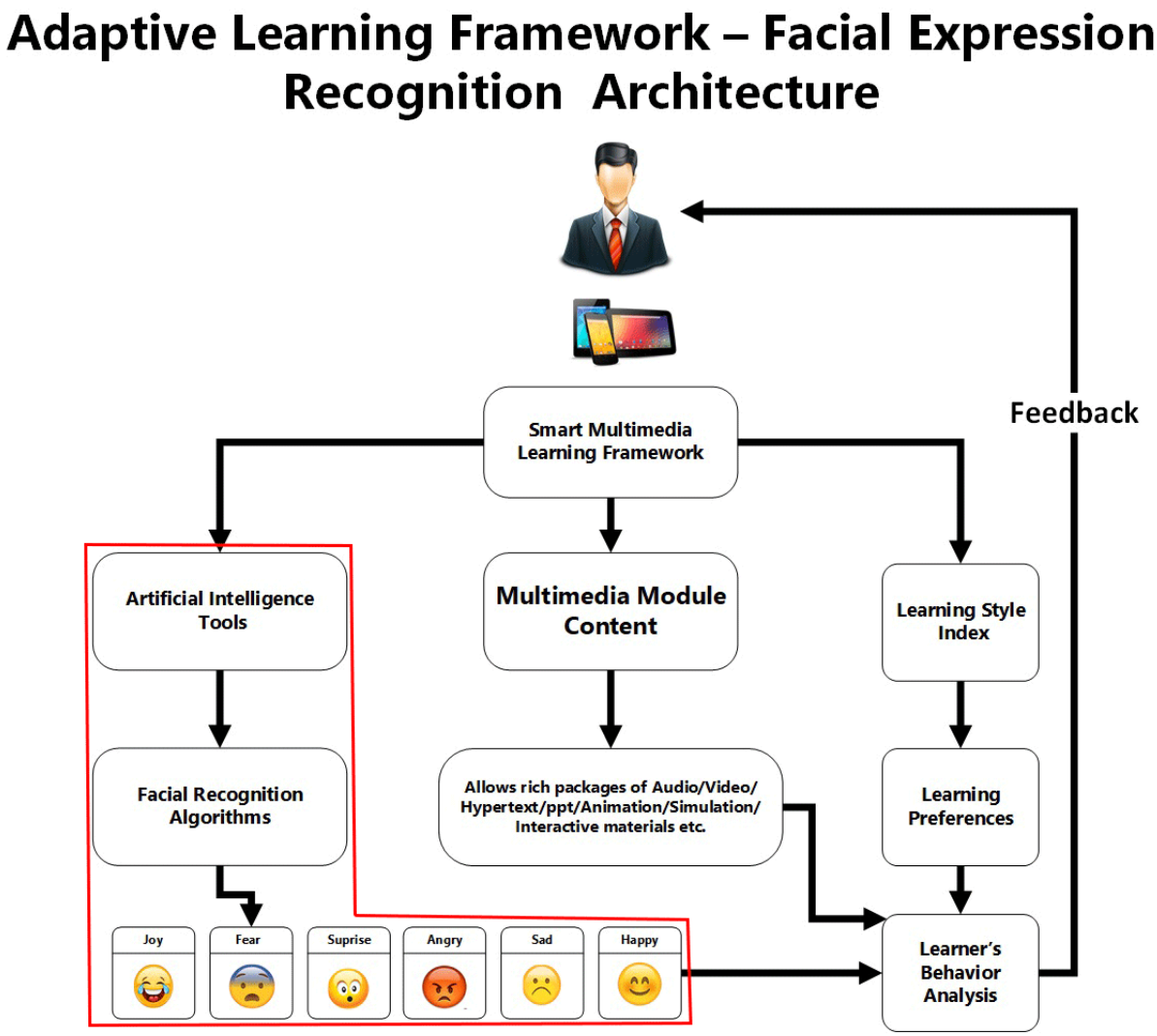


Figure 3.2: Adaptive Learning Framework Model

3.5.2 System Process Diagram

This process diagram enable us to describe the step-by-step flow of activities that occur in the facial expression recognition system. Figure 3.3 shows the system process diagram. The image capture only begins after user log-in successfully into the application. Talking about real-time, pictures are not taken explicitly but frames are collected. Therefore frame captures has to be clear for further analysis to begin although this happen within a very short time, its is necessary to emphasize that our

image analysis algorithm only work with clear images. Next is detection of expression in the analyzed image through matching. If found, metric indication appear and show the degree of the match in real-time.

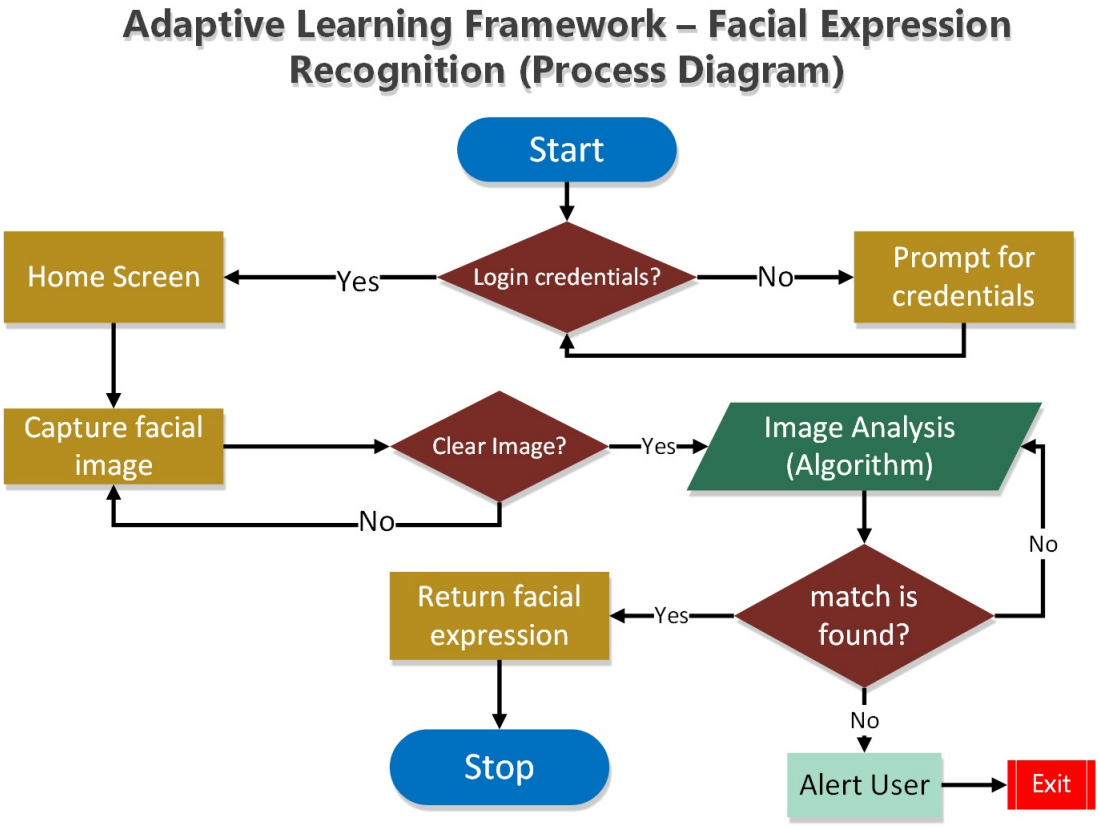


Figure 3.3: System Process Diagram

3.5.3 System Use-case Diagram

This diagram ensure that different actors that interact with the system are well captured. Figure 3.4 shows how a user interacts with the system, learner inputs to the system, in this case, after log-in activities are successfully done, learner is required to provide facial image for processing recognition. Our smart phone quickly loads the trained algorithm through the mobile application and provide feedback to user on the recognized expression. In further implementation of this work, Learning resource database will be provided in other to access learning materials as well as store learner preferences for adaptive decision when required.

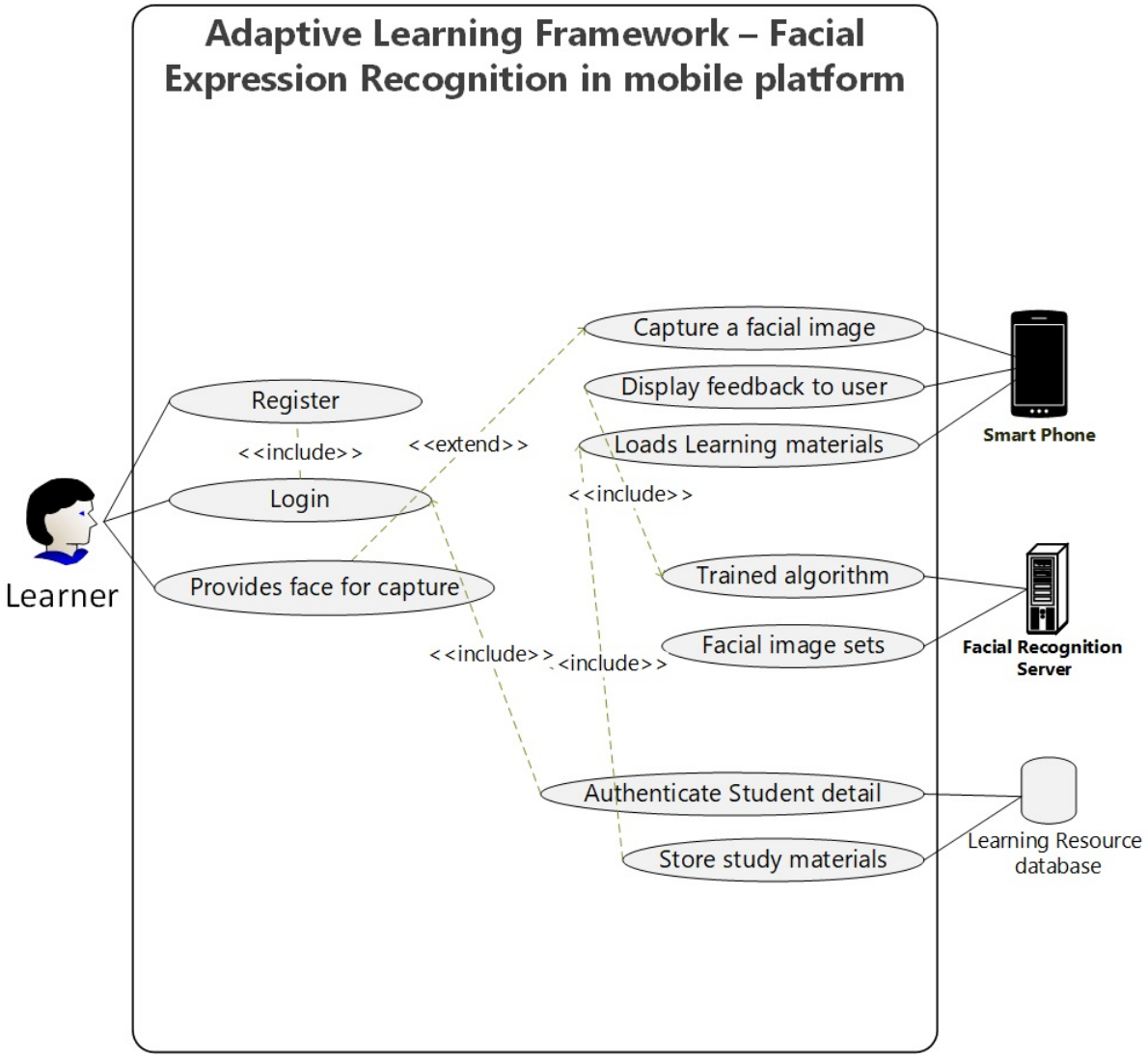


Figure 3.4: System Use-case Diagram

3.6 Android Application Development

Over the years, Application developments have become a serious business, In order to demonstrate this work we have designed an application for mobile smart phone compatible with Android OS. One of the major reason for our choice is that android is open-source and hence, limitation is minimal. Among others are Android Studio, Ionic framework & phonegap. Broadly divided into native application development and cross-platform. Android studio provide native implementation of android application and our SDK is for Android platform.

Algorithm for Android Application Development :

1: **procedure** APPLICATION($PC, config$) ▷ JDK configured
2: $SDK \leftarrow Emulator$ and API Build tools
3: **while** *Environment setup is OK* **do** ▷ use Android Studio
4: *activity UI design* $\leftarrow xml$
5: *activity run implementation* $\leftarrow java$
6: *application permission* $\leftarrow$ *android manifiest*
7: *communication between & within application* $\leftarrow$ *intent*
8: **return** APK ▷ android phone installable

3.7 Effectiva SDK

The Expression recognition SDK (API also available) is designed to analyze spontaneous facial expressions shown by people show in their daily interactions. This technology works with optical sensor, device camera or standard web-cam. Computer vision algorithms identify key features on the face for example the corners of your eyebrows, the tip of your nose, the corners of your mouth through edge detection. Machine learning algorithms (classifiers) thereafter analyze pixels in those regions to understand and classify facial expressions. To classify facial expression recognition Facial Action Coding System (FACS) or Action Units (AUs). Combinations of these facial expressions are then mapped to emotions (Software, 2009). This work was implemented using android studio. The Emotion SDK for Android is provided as an .aar archive. We included this in our application by declaring a dependency on the SDK in the application's build.gradle file found under android studio.

3.8 Alternative Design Consideration

During this research work, other effective options were explored to ensure good result in fulfilling this project objective. Due to time constraint, we have chosen SDK implementation among the rest, non the less, in future work we aim to take other alternative to completion.

3.8.1 Image Recognition Using AAM

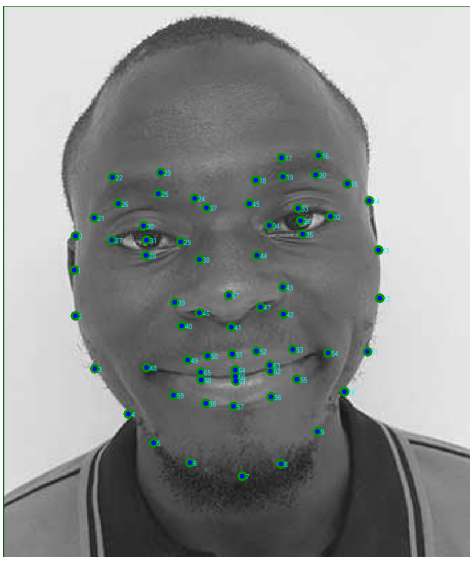
The Active Appearance Model (AAM) is a generalization of the widely used Active Shape Model approach, but uses all the information in the image region covered by the target object, rather than just that near modeled edges.

An AAM contains a statistical model of the shape and grey-level appearance of the object of interest which can generalize to almost any valid example. Matching to an image involves finding model parameters which minimize the difference between the image and a synthesized model example, projected into the image. The potentially large number of parameters makes this a difficult problem.

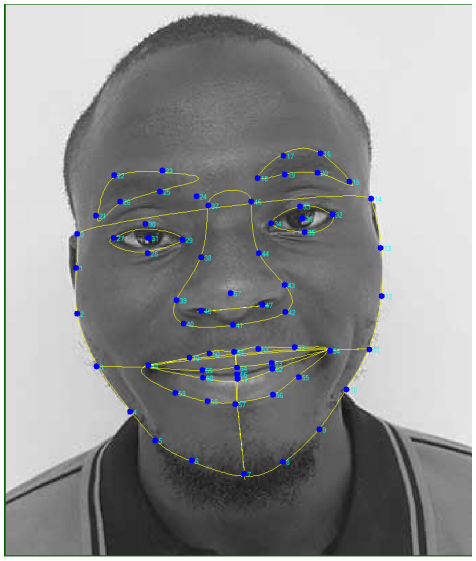
We observe that displacing each model parameter from the correct value induces a particular pattern in the residuals. In a training phase, the AAM learns a linear model of the relationship between parameter displacements and the induced residuals. During search it measures the residuals and uses this model to correct the current parameters, leading to a better fit. A good overall match is obtained in a few iterations, even from poor starting estimates (Cootes et al., 1998).

The hardware available impacts the number of frames that can be processed per second. Typically it is possible to achieve frame rates of 20 Frames per Second (FPS) on mobile devices as implemented in this work and 30 FPS or above on laptop/desktop devices. Our demonstration will allow the users to get real-time feedback on their facial expressions.

Facial feature marking and model building: In this work, we carried out further exploration using active appearance model. This involves the marking of important feature of the face that may vary in shape during a facial expression. The figure 3.5b 3.5a below shows a a marked image which can further be implemented in android smart phones.



(a) Facial marking using AAM tool



(b) Facial feature shapes(Shape Model)

Figure 3.5: Facial Image feature marking and model building using AAM tool

3.9 Summary

This chapter provided the methodology and system analysis of this research. Major system design approaches were discussed as well as the model of the software developed. This is mainly intended to provide clear understanding of how the problem solved in this study was designed and represented. Our concern for alternative design as described above was also present with promising advantage.

CHAPTER FOUR

Data Analysis and Discussion of Results

This chapter discussed system design considerations, implemented to ensure good result as well as result discussion. Specific reasons for some of our approaches and how they can assist us meet our goals are explained in details. We also discussed important working mechanism of our approach with the result gotten from the testing phase. This chapter is concluded by discussion of user evaluation from questionnaire provided.

4.1 Image Model Training

After collection of image data-sets, we used Active appearance Model (AAM) tool to mark features of the images from which a dot smd .smd) file is build from point files. This model was further subjected to training with a number images whose features are quiet different. This enable the algorithm to learn from other similar images for wider understanding.

4.2 Facial Recognition and Metric Display

From the provided Efectiva SDK, metric display functionality is available to show the degree of facial expression recognition. This provide a great deal of understanding as learners decision may be taken only when the degree is high. Accuracy of facial expression recognition is very high and image matching provide effective result.

4.2.1 Facial Recognition SDK features

- **Implemented:** This involves the sections of the facial recognition SDK that were implemented in this research work.

- Facial Detection: This involves recognition of human face in real-time. Face tracking is also included in this section
- Facial Expression Recognition: The emotional expressions implemented includes Anger, Disgust, Fear, Joy, Sadness and Surprise. This recognized emotion is indicated by metric display of the value or degree of recognition (usually 1-100)
- Gender Recognition: This feature enable exact detection of gender from the face provided.
- Glasses Recognition: Stronger facial analysis makes it possible to recognize object around the face as this feature enable recognition of glasses whether on or not

Further Work: There were other features of the SDK that were not implemented, this was due to our research scope definition and time constraint.

- Multiface Recognition: This feature allow multiple facial expression recognition in real time using the camera of an android phone
- Emoji Display from Recognized expression: For better understanding, emoji feature were also available for output display as a clearer indication of the emotion recognized.

4.2.2 Class Diagram of Facial Recognition System Implemented

Figure 4.1 show the class relationship as implemented from the Effectiva Software Develoment Kit (SDK).

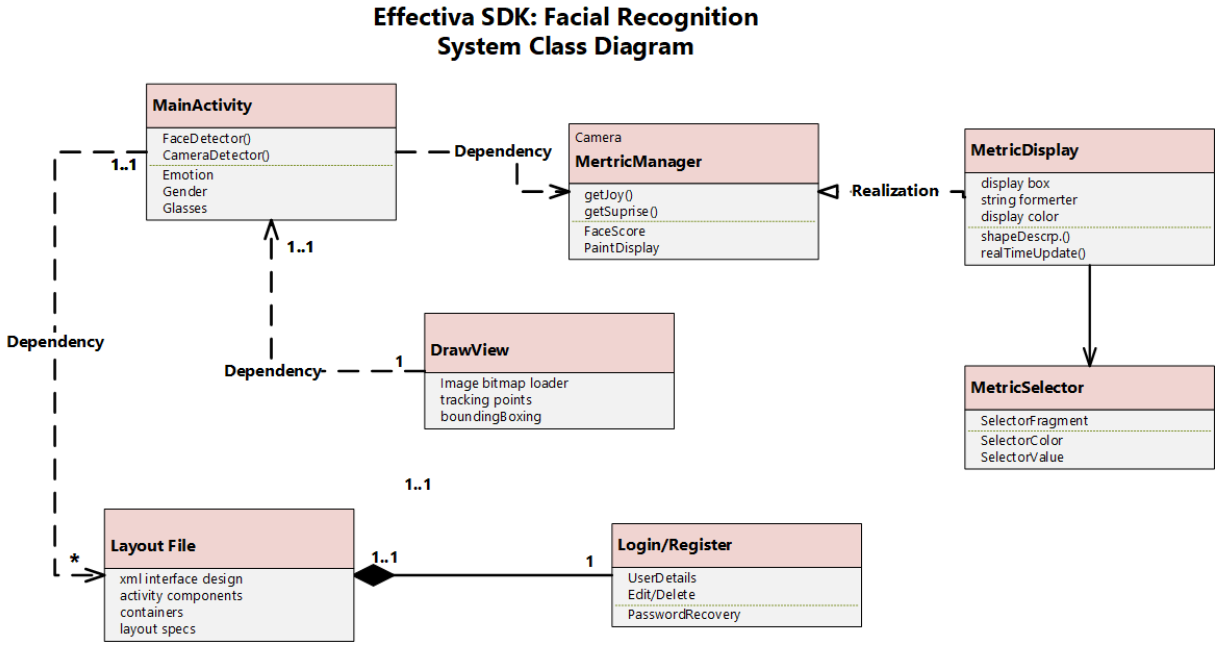
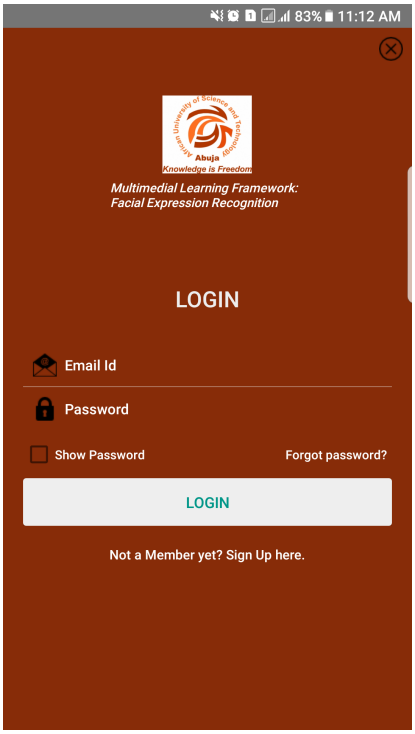


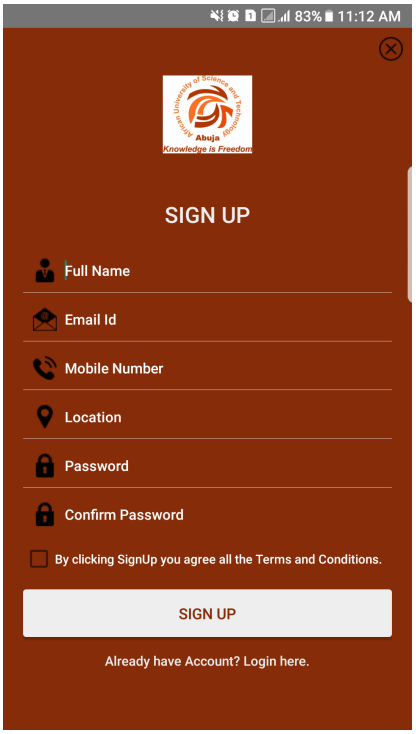
Figure 4.1: Class Diagram of Facial Recognition System

4.3 Input & Output Screens

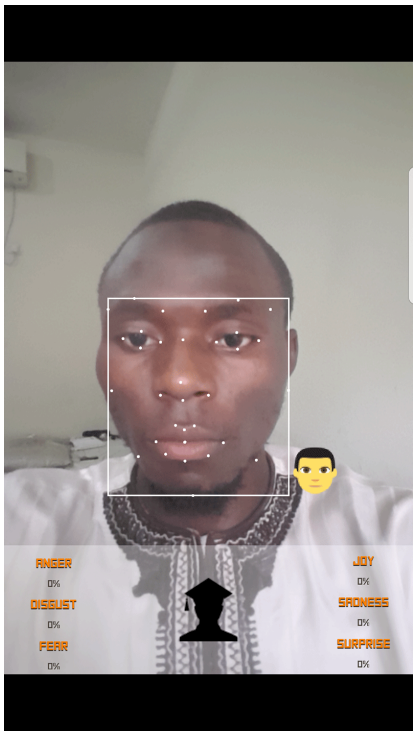
Figures 4.1 (a, b & c) and 4.2 (a, b & c) show a number of major input and output screens from the android application developed using android studio. These are majorly display of screen shots from the android application.



(a) Learner login screen

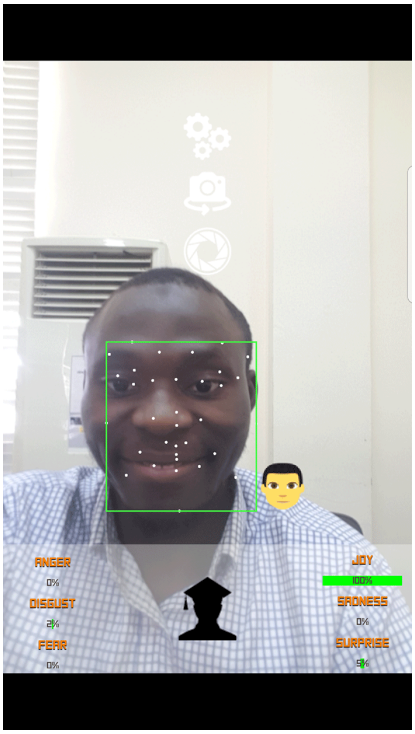


(b) Learner registration screen

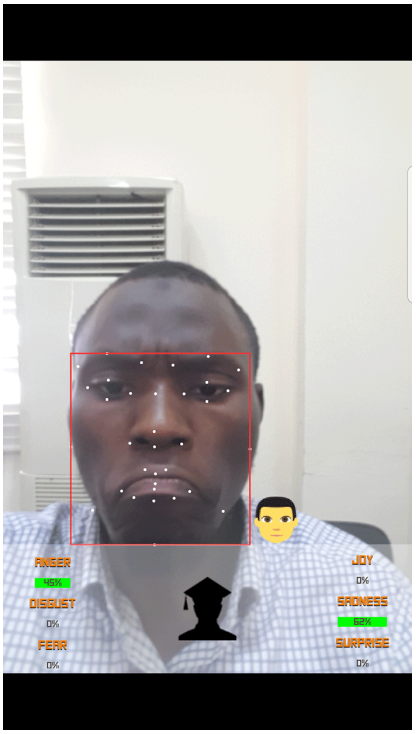


(c) No Expression case

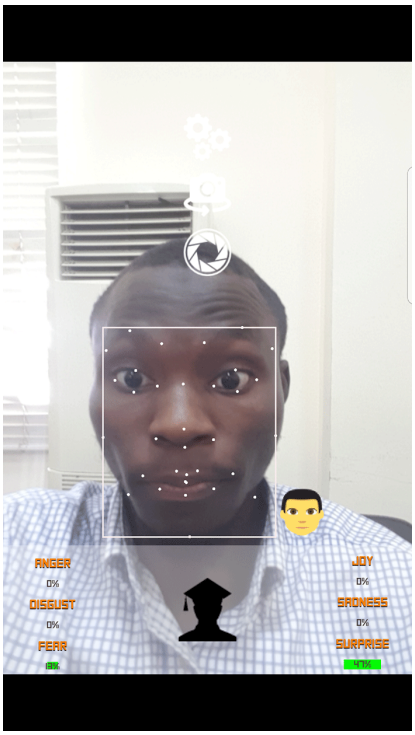
Figure 4.2: Display of Learner Login screen and normal case



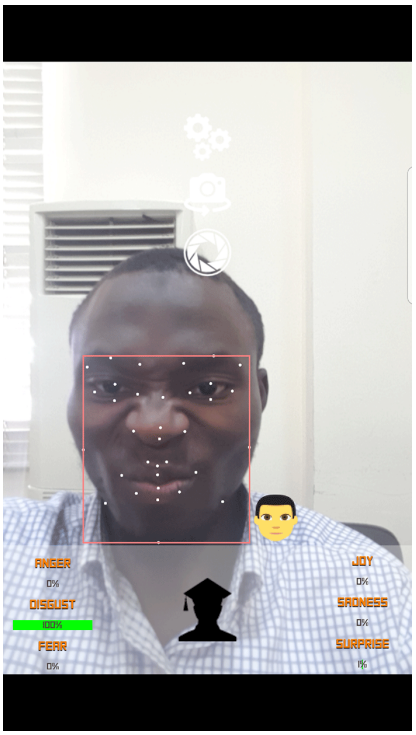
(a) Joy detection



(b) multi expression detection



(c) Suprise expression



(d) Disgust expression

Figure 4.3: Facial Expression Recognition.

4.4 Accuracy Test

Table 4.1 shows the items considered during the evaluation of the validity of the system. It represents the degree at which facial expression are correctly detected. The evaluation of our system is concluded to be right or wrong by the decision of the intended expression of the learner . Base on this consideration, 30 system users are provided this evaluation form to fill and result was generated base on the feed-back.

Table 4.1: Sample Accuracy Test

SN	Learner	Detected Exp.	Actual Expression	Remark
1	A	Joy	Joy	Right
2	B	Disgust, Fear	Disgust	Right
3	C	Surprise	Surprise	Right
4	D	Sad	Disgust	Wrong
5	E	Angry, Disgust	Angry	Right

The pie chart figure 4.4 shows a conclusive illustration of the general correctness of our facial expression recognition. This chart was generated from feed-back gotten form 30 system users.

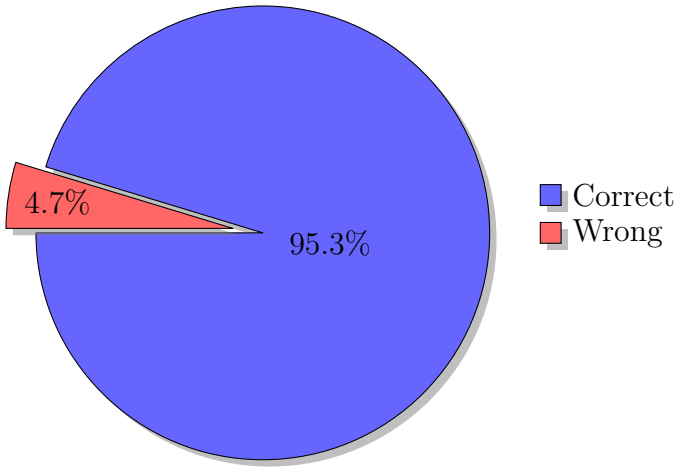


Figure 4.4: Pie chart of system Accuracy test

4.5 Adaptive Decision In Smart Learning Environment

Based on the fundamental objective of this work, we aim to utilize the result gotten from this facial recognition to satisfy leaner desired choice in order to enhance adaptive learning process in a smart learning environment.

4.6 Contribution of the Research

Major focus of this research effort is to implement facial expression recognition in smart phone which helps to make effective adaptive decisions. This is a novel approach in Adaptive learning framework as discussed from work of other researchers.

4.7 Summary

In this chapter, we discussed our results and effectiveness the facial expression recognition system. User evaluation and result are represented above. Its it obvious that the result is good when compare to result of other researchers, the relevance of this facial expression recognition in adaptive decision making is also demonstrated as learners are never demoralized due to wrong decision made.

CHAPTER FIVE

Summary, Conclusion and Recommendations

In this chapter, we discussed summary of our work in this module, highlighted challenges and further research work.

5.1 Summary

A novel method for facial expression recognition in smart phone through camera frames using Facial Action Coding System (FACS) is implemented as provided by Effectiva SDK in this research effort. FACS is described as a tool for measuring facial expressions. It is an anatomical system for describing all observable facial movement. It breaks down facial expression into individual components of muscle movement. This technique was first published by Ekman & Friesen in 1978 and has gone through optimization as other researchers revise the work.

5.1.1 Challenges and Lessons Learned

Android Application Development Although, we are familiar with mobile application development using android, implementation of this SDK was quiet hectic and demands careful approach. Online guide provided was very helpful as this work require other functionalities in the software development.

Image marking with Active Appearance Model (AAM) tool During the period of this project, We explored the use of Active appearance model tool. Facial images were taken and feature marking was done to produce point files and dot SMD file (model). This procedures entails lots of ambiguity and uncertainty. We were unable to implement this approach in smart mobile devices.

5.2 Conclusion

With Significant Improvement in the understanding between user and a smart learning environment, significant adaptation level through careful observation & understanding is required to ensure user effective learning, user experience and overall satisfaction.

5.3 Recommendations and Further Research Work

This system possesses generality advantage and other techniques for optimization exist and should be discussed as further exploration. This system can be improved with better performance and accuracy with enhance user friendliness.

Active Appearance Model (AAM) algorithm implementation in smart phone In search of better result, AAM can be implement in order to demonstrate its accurate working mechanism as described above. Although some work has been done during the exploration stage of this project, high quality model should be built and training with large data set.

Cross-platform Implementation of Facial Expression Recognition In order to enhance user experience and promote software portability across difference platforms, implementation can be done on cross-platform framework of mobile application development like ionic framework and phongap etc. This is necessary in order ensure high availablity for users across different mobile platform.

Multi-face recognition This system can be optimize to recognize multiple facial expression. This idea can be implemented to consider facial recognition from a camera for a group of learners. Although, this method also result i higher complexity but also batch processing is possible.

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Appendix A

Program Design, Algorithm mind map of Adaptive Learning Framework

Algorithm for Android Application Development :

1: **procedure** APPLICATION($PC, config$) ▷ JDK configured
2: $SDK \leftarrow Emulator$ and API Build tools
3: **while** *Environment setup is OK* **do** ▷ use Android Studio
4: *activity UI design* $\leftarrow xml$
5: *activity run implementation* $\leftarrow java$
6: *application permission* $\leftarrow$ *android manifiest*
7: *communication between & within application* $\leftarrow$ *intent*
8: **return** APK ▷ android phone installable

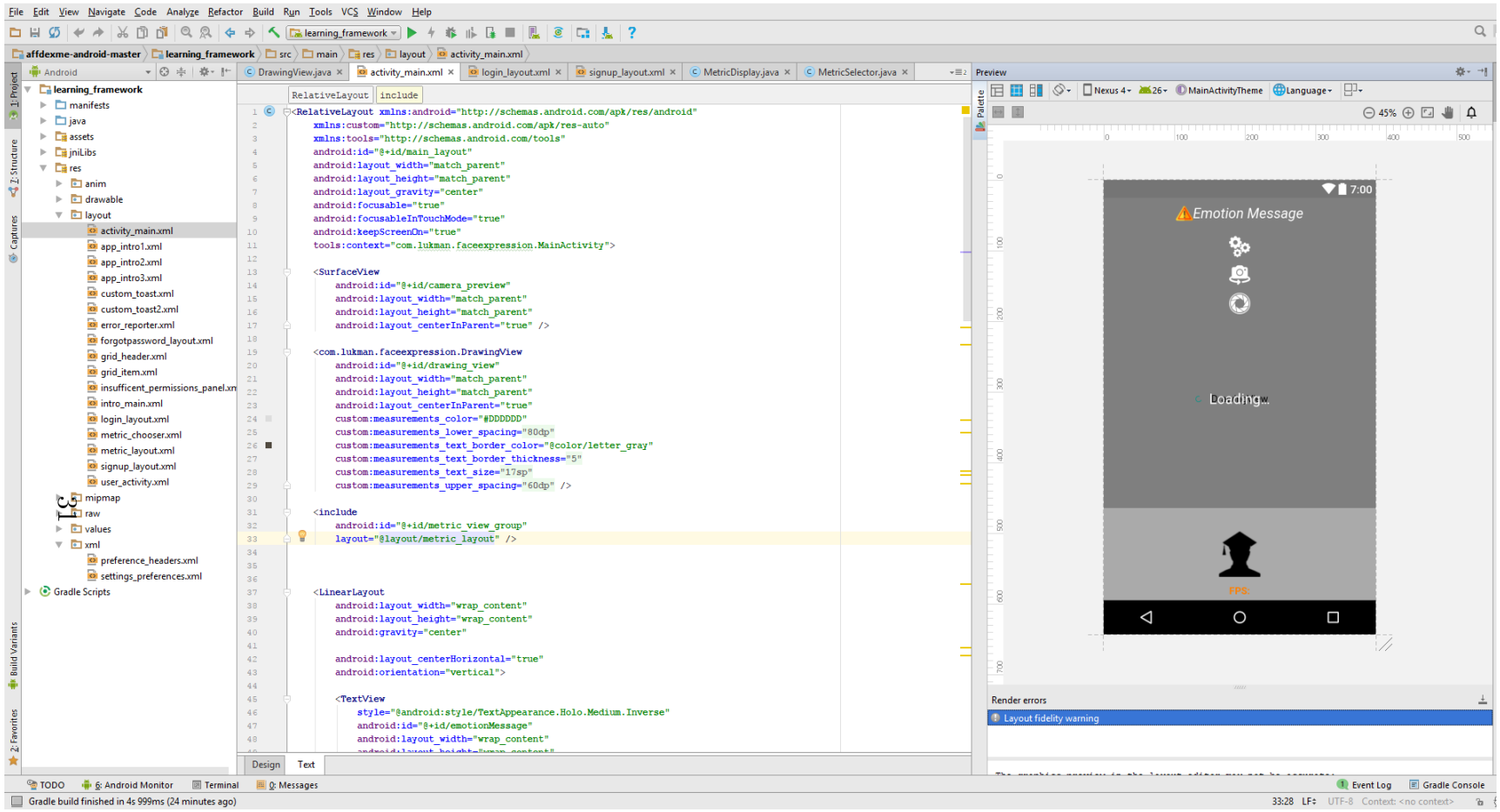

Figure 5.5: Android Studio Development Environment

Appendix B

Code Snippet from facial expression recognition using Effectiva SDK

Selection of dominant Emotion

```
1
2  if (f.emotions.getAnger() > dominantMetricValue) {
3        dominantMetricName = MetricsManager.getCapitalizedName(MetricsManager.Emotions.ANGER);
4        dominantMetricValue = f.emotions.getAnger();
5  }
6  if (f.emotions.getContempt() > dominantMetricValue) {
7       dominantMetricName = MetricsManager.getCapitalizedName(MetricsManager.Emotions.CONTEMPT);
8          dominantMetricValue = f.emotions.getContempt();
9  }
10  if (f.emotions.getDisgust() > dominantMetricValue) {
11       dominantMetricName = MetricsManager.getCapitalizedName(MetricsManager.Emotions.DISGUST);
12       EmoMesg = (getResources().getString(R.string.emotionMsgDisgust));
13       dominantMetricValue = f.emotions.getDisgust();
14 }
15 if (f.emotions.getFear() > dominantMetricValue) {
16       dominantMetricName = MetricsManager.getCapitalizedName(MetricsManager.Emotions.FEAR);
17       dominantMetricValue = f.emotions.getFear();
18 }
19 if (f.emotions.getJoy() > dominantMetricValue) {
20       dominantMetricName = MetricsManager.getCapitalizedName(MetricsManager.Emotions.JOY);
21       dominantMetricValue = f.emotions.getJoy();
22 }
23 if (f.emotions.getSadness() > dominantMetricValue) {
24       dominantMetricName = MetricsManager.getCapitalizedName(MetricsManager.Emotions.SADNESS);
25       EmoMesg = (getResources().getString(R.string.emotionMsgSad));
26       dominantMetricValue = f.emotions.getSadness();
27 }
28 if (f.emotions.getSurprise() > dominantMetricValue) {
29      dominantMetricName = MetricsManager.getCapitalizedName(MetricsManager.Emotions.SURPRISE);
30      dominantMetricValue = f.emotions.getSurprise();
31 }
32 if (dominantMetricName.isEmpty()) {
33      return null;
34     } else {
35         return new Pair<>(dominantMetricName, dominantMetricValue);
36       }
```

Setting facial Score

```
public void setScore(float s) {
   text = String.format("%.0f%%", s);  //change the text of the view
   //shading mode is turned on for Valence, which causes this view to shade its color according
   //to the value of 's'
   if (isShadedMetricView) {
       if (s > 0) {
           left = midX - (halfWidth * (s / 100));
           right = midX + (halfWidth * (s / 100));
       } else {
           left = midX - (halfWidth * (-s / 100));
       right = midX + (halfWidth * (-s / 100));
       }
       if (s > 0) {
           float colorScore = ((100f - s) / 100f) * 255;
           boxPaint.setColor(Color.rgb((int) colorScore, 255, (int) colorScore));
       } else {
         float colorScore = ((100f + s) / 100f) * 255;
         boxPaint.setColor(Color.rgb(255, (int) colorScore, (int) colorScore));
       }
       } else {
         left = midX - (halfWidth * (s / 100));
         //change the coordinates at which the colored bar will be drawn
         right = midX + (halfWidth * (s / 100));
        }
        invalidate(); //instruct Android to re-draw our view, now that the text has changed
}
```