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A DEEP LEARNING-BASED TECHNIQUE FOR MEASURING THE SUCCESS OF ORTHODONTIC TREATMENT

Qabas Abdal Zahraa Jabbar[1*], Firas Ali Hashim[2], Nada Thanoon Ahmed[3], Nadia Mahmood Hussien[4], Yasmin Makki Mohialden[5], Itidal Saad Mohammed[6]

[1]Computer Science Department, Collage of Science, Mustansiriyah University, Baghdad, Iraq,*
Email:- qabas_a@uomustansiriyah.edu.iq
[2]Computer Science Department, Collage of Science, Mustansiriyah University, Baghdad, Iraq
Email:- Firas70@uomustansiriyah.edu.iq
[3]Computer Science Department, Collage of Science, Mustansiriyah University, Baghdad, Iraq
Email:- qabas_a@uomustansiriyah.edu.iq, nada_thanoon@uomustansiriyah.edu
[4]Computer Science Department, Collage of Science, Mustansiriyah University, Baghdad,Iraq
Email:- nadia.cs89@uomustansiriyah.edu.iq
[5]Computer Science Department, Collage of Science, Mustansiriyah University, Baghdad,Iraq
Email:- ymmiraq2009@uomustansiriyah.edu.iq
[6]Computer Science Department, Collage of Science, Mustansiriyah University, Baghdad , Iraq
Email:- ynchardlik77m@gmail.com

***Corresponding Author:**
qabas_a@uomustansiriyah.edu.iq

Abstract

Orthodontics is one of the most advanced procedures for achieving long-term stability with functional and aesthetically pleasing results. This study aims to evaluate the effectiveness of orthodontics by measuring the distances between each pair of teeth using k-means algorithm utilities from deep learning. The system creates Python-based tools, such as Numpy and OpenCV, from an integrated package. This instrument can assist the dentist in making decisions regarding gum disease, dental impaction, excessive teeth, tooth loss, and orthodontics. Because making an informed decision on an extraction pattern is crucial to the success of orthodontic treatment and the stability of long-term outcomes.

Keywords: *Artificial intelligence deep learning, diagnostics, dental care.*

INTRODUCTION

The terms "quality of life" (QOL) and "health-related QOL" (HRQL) have developed more public in the medical literature as adults' demand for orthodontic treatment has increased, particularly in the last 10 to 15 years. A considerable amount of orthodontic therapy is justified by an improvement in HQOL. In light of this, research on HRQL in orthodontic patients may aid in improving care by disclosing information regarding treatment needs and outcomes. As a result, clinicians should be aware of some of the procedures used to assess HQOL (Cobourne et al., 2015; Cunningham et al., 2001).

Biology, psychology, and economics employ clustering extensively. Changes in cluster parameters affect clustering results. The number of clusters or model parameters must be calculated before clustering. Several cluster routes have been suggested. The K-means clustering method is simple and rapid. We utilize k-means to select clusters. We could ask end users for clusters in advance, but this is impractical because each dataset requires subject expertise. Statistical indices, the variance-based approach, information theory, and the goodness-of-fit method can be used to estimate clusters. This article examines k-means for clustering X-ray images (Kodinariya et al., 2013). Gary Brodsky created OpenCV for Intel in 1999. It's constantly evolving and supports computer vision and ML techniques. OpenCV supports C++, Java, and Python and is available on Linux, iOS, Windows, OS X, and Android. CUDA and OpenCL-based GPU interfaces are also being developed. OpenCV-Python is its Python API. Python, the C++ API, and OpenCV are all usable. Guido van Rossum's Python gained popularity due to its user-friendliness and understandable source code. It lets programmers communicate concepts with minimal code while maintaining output readability (Mordvint-Sev et al., 2014).

NumPy is the Python standard for scientific apps (Cobourne et al., 2015). It offers high-level math and powerful objects. NumPy supports declarative vector programming, which employs arrays instead of scalars. This method is called "array programming" or "vector programming" in HPF, Armadillo, MATLAB, etc. (Kristensen et al., 2013; Ranjani et al., 2019).

1. Related work

This literature review (Reyes et al., 2021) explains why ML has been used in different parts of dentistry and describes common algorithms.

This work aimed to design and test deep learning algorithms and object recognition methods for autonomously diagnosing periodontal disease in orthodontic patients using intraoral pictures. This study included 134 intraoral images, which were split into two datasets: a training dataset of 107, or 80% of the total, and a test dataset of 27. Using ResNet-50, two faster R-CNN models were developed (CNN). In the second model, gingival inflammation is in the ROI, while teeth are in the first. First, the proposed model's detection accuracy, precision, recall and mean average precision were calculated (map). The teeth recognition model has a 51.85% recall, 100% accuracy, and 100% mAP. The model's accuracy, precision, remember, and mean absolute percentage **were 77.12%, 88.02%, 41.75%, and 68.19%, respectively.**

This study believes intraoral images and deep learning models can discover and diagnose gingivitis. This shows how technology can be used in dentistry to discover periodontal disease without harming the tooth (Alalharith et al., 2020). This can lessen global disease severity.

This scoping study explores AI-based orthodontic landmark identification, diagnosis, and treatment planning. Using Embase, PubMed, Scopus, and Google Scholar, a thorough search was conducted. In this study, the Quality Assessment and Diagnostic Accuracy Tool 2 (QUADAS-2) was utilized to evaluate the papers (Mohammad-Rahimi et al., 2021).

2. Proposed methodology

Orthodontics is commonly used in the process of orthodontic therapy to correct tooth alignment (Zamani et al., 2022). This work created a method to measure the success of orthodontic treatment by measuring the distances between teeth using mandibular dental arch forms, utilizing the k-means clustering technique based on these distances, and using clever Python tools.

The k-means algorithm is a well-known clustering technique. Several k-means variants have been proposed in the literature. Even though pattern recognition and ML clustering involve unsupervised learning, the k-means approach is usually influenced by a large number of clusters. The k-means approach isn't unsupervised clustering by itself (Sinaga et al., 2020). In this post, we create unsupervised learning for k-means. This schema can discover the optimal number of clusters to run simultaneously and requires no parameter setting. In other words, we offer a new unsupervised k-means (U-k-means) clustering approach that computes the best number of clusters on its own and requires no setup or parameter selection. We also analyze the U-K-means clustering technique's computing cost. General algorithm steps:

This tool's input is an X-ray.

1. open-CV package utilities for altering the image; j package utilities to define criteria, the number of clusters (K), and apply k-means();
2. convert the back to uint8 and produce the original image
3. determine the distance between X-ray teeth; and
4. Make a decision.

Testing

In the testing area, you can observe the results from two perspectives:

1. Orthodontic treatment doesn't work if the numbers of the tooth rows don't match (Figures 1 and 2).

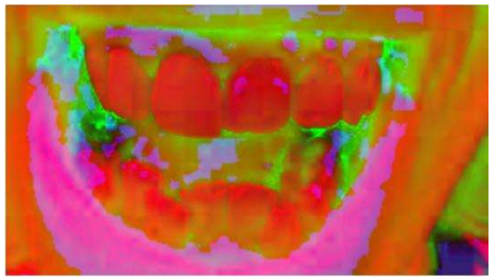
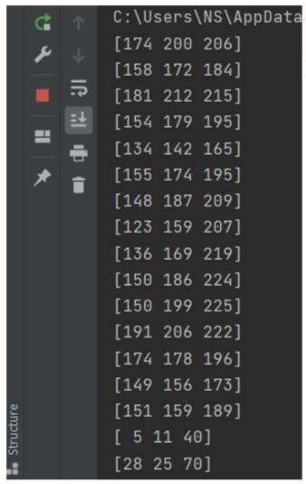


Fig. 1. Image manipulate by open-CV 1



```
C:\Users\NS\AppData
[174 200 206]
[158 172 184]
[181 212 215]
[154 179 195]
[134 142 165]
[155 174 195]
[148 187 209]
[123 159 207]
[136 169 219]
[150 186 224]
[150 199 225]
[191 206 222]
[174 178 196]
[149 156 173]
[151 159 189]
[ 5 11 40]
[28 25 70]
```

Fig. 2. Teeth point values for Orthodontics treatment failed

1. If the numbers in the array for the tooth points are approximately equal, then orthodontic treatment is successful, as shown in Figures 3 and 4.

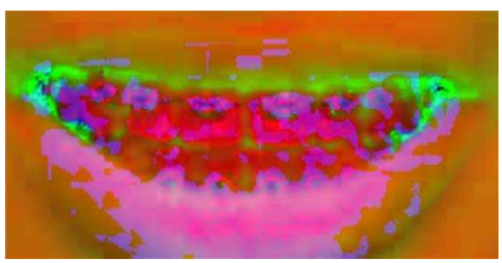
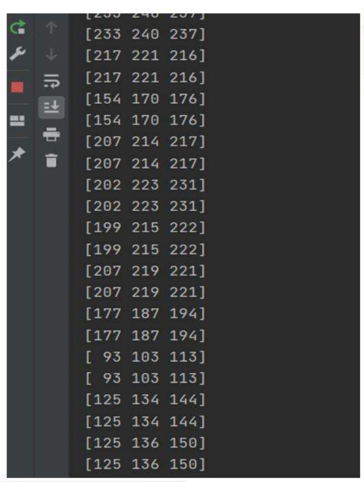


Fig. 3. Orthodontics Image manipulate by open-CV 2



```
[233 240 237]
[217 221 216]
[217 221 216]
[154 170 176]
[154 170 176]
[207 214 217]
[207 214 217]
[202 223 231]
[202 223 231]
[199 215 222]
[199 215 222]
[207 219 221]
[207 219 221]
[177 187 194]
[177 187 194]
[ 93 103 113]
[ 93 103 113]
[125 134 144]
[125 134 144]
[125 136 150]
[125 136 150]
```

Fig. 4. Teeth point Values for successful Orthodontics treatment

Conclusion

AI can help orthodontists save time and type diagnoses and estimates that are as accurate as those made by trained dentists. The goal of these systems is to improve performance and care in orthodontics. However, based on the studies that have been conducted so far, the most promising uses are for finding landmarks in cephalometric, classifying the skeleton, and making decisions about tooth extractions.

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