Detection of treatments on dental x-rays Using Deep Learning

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Introduction

Dental radiography interpretation is often a time-consuming and error-prone process due to a high variety of dental structures and a large amount of X-rays to be analysed on an everyday basis. The automated system can support dentists in their daily practice saving time and improving quality of dental diagnosis

Business Requirement

Identify objects and tag in a dental panoramic radiography images to detect dental treatments like filling, crown, bridge, root canal, post and implant. Overlay these tags over the object. Also colour code image based on density and label tooth with number (1 through 32). Classify accordingly with relative strength and confidence of accuracy (i.e. 97%) and output these Meta tags that classify accordingly (i.e. Tooth #3 - Crown/Root Canal).This should all be done in a web/mobile environment and API made available so that third parties can send images to predict, detect and analyse and return the results back into their system.

Current System

Dentists usually need to serve numerous patients every day. As an important auxiliary diagnostic tool, a large number of dental X-ray films are photographed daily. Dental radiographs are essential in oral diagnostic procedures. Because the film reading work is primarily conducted by dentists, it occupies several valuable clinical hours and may cause misdiagnosis or underdiagnoses owing to personal factors, such as fatigue, emotions, and low experience levels. The work burden of a dentist and the occurrences of misdiagnosis may be reduced if intelligent dental X-ray film interpretation tools are developed to improve the quality of dental care. From this perspective, automatic teeth identification, numbering and detection of treatments on dental x-rays are done using Artificial Intelligence and Deep learning algorithms.

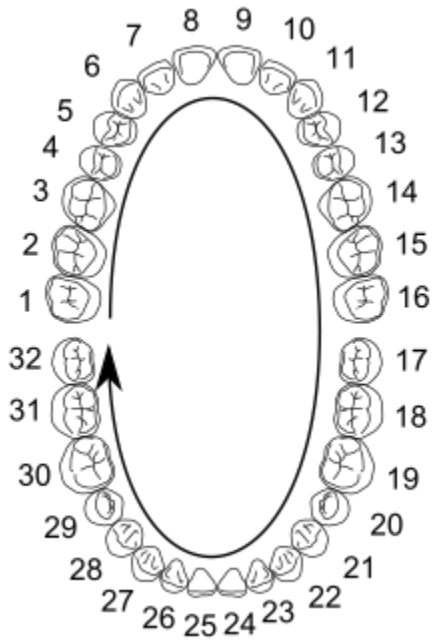
Proposed System

Proposed system uses Artificial intelligence and deep learning algorithms to detect treatments on dental x-rays. Deep learning techniques are used in object localization and classification.

A panoramic X-Ray is used as an input for the system. The X-ray films used in this project were selected from various sources without extraction of patients' private information, such as name, gender, age, address, phone numbers, etc. A total of 150 dental panoramic x-ray images were collected approximately (300 to 500) × (300 to 400) pixels and saved as a "JPG" or "PNG" format image file with a specific identification code.

The teeth detection module uses darkflow which is an open source project for Yolo (You Only Look Once) algorithm for object detection.
The methodology followed includes
1. Collection of dataset: In this case panoramic dental x rays with different dental treatments like root canal, filling, crown, implant, post and bridge.
2. Pre-processing the collected dataset: An annotation file has to be created for each image and that is done with the help of labelling tool. The tool creates an xml file which includes the coordinates of objects in the image and associated labels.
3. Create the configuration of the model with the number of classes and number of filters accordingly.
4. Train the model with the collected pre-processed images and corresponding annotation files.
5. Predict the result.

The teeth detection module outputs the bounding box coordinates for all the teeth detected on an image. The teeth numbering module uses output of the teeth detection module: it crops the teeth based on the bounding box coordinates, processes each tooth to classify it with the tooth number. The "universal numbering system", is used here to number the teeth as shown below.



The numbers 1 - 32 are used for permanent teeth. The tooth designated "1" is the maxillary right third molar ("wisdom tooth") and the count continues along the upper teeth to the left side. Then the count begins at the mandibular left third molar, designated number 17, and continues along the bottom teeth to the right side. Each tooth has a unique number or letter.

Colour coding and shadow marking is done by image enhancing method based on Histogram Equalisation. Different colour codes are assigned for different range of pixel intensities

Finally the system will output the treatment done on the tooth i.e. Tooth #3 - Crown/Root Canal, Tooth #32 – Filling (as shown in the below figure2).

Technologies Used

- Python
- AI and Deep learning
- OpenCV
- Yolo V2 Darkflow
- Histogram equalisation

Risks and Challenges

Below are the risk identified for implementing proposed system;

1. Finding a data set is the major risk encountered during processing
2. Quality of the image which affects the accuracy of the output
3. Detecting multiple objects with similar shapes in a same image
4. Time consumption for training
5. Need of high system configuration like GPU for image processing during training

Results/ Output

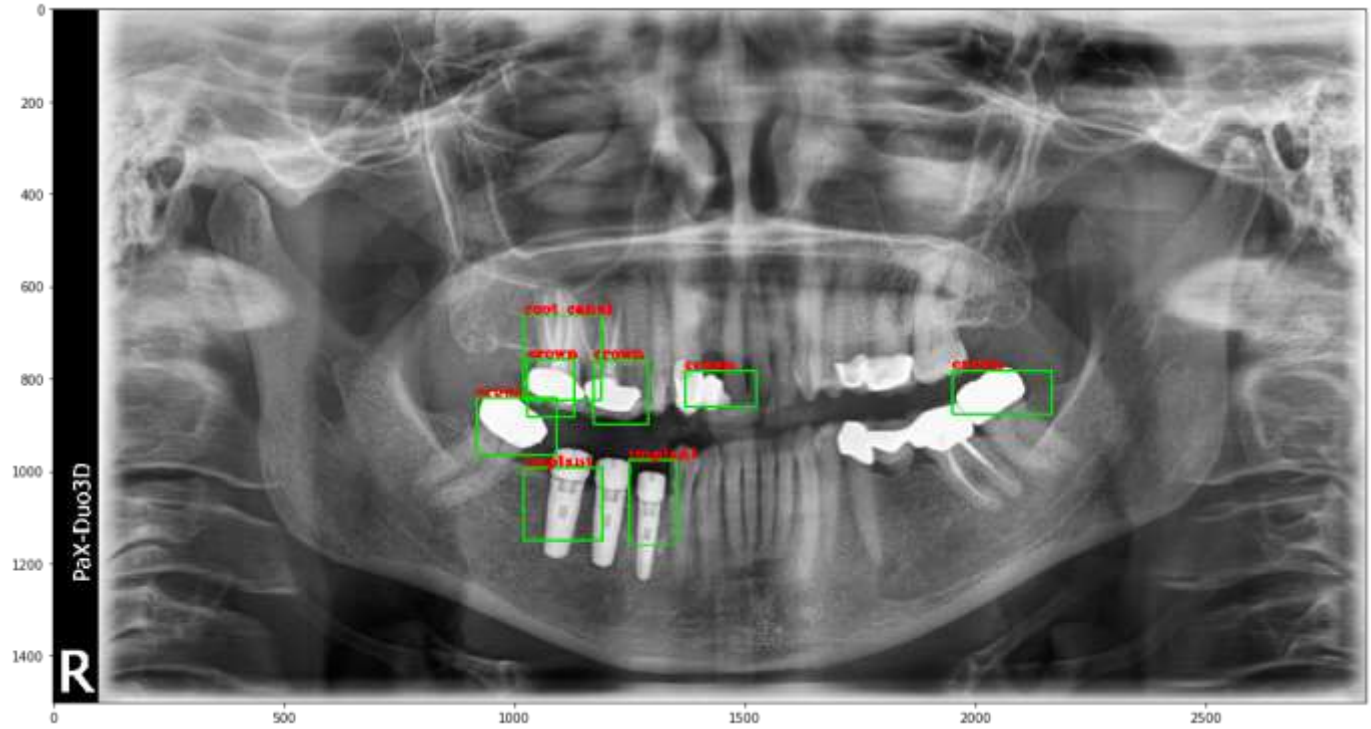


Figure 1 Dental Treatment identification from panoramic x-ray image

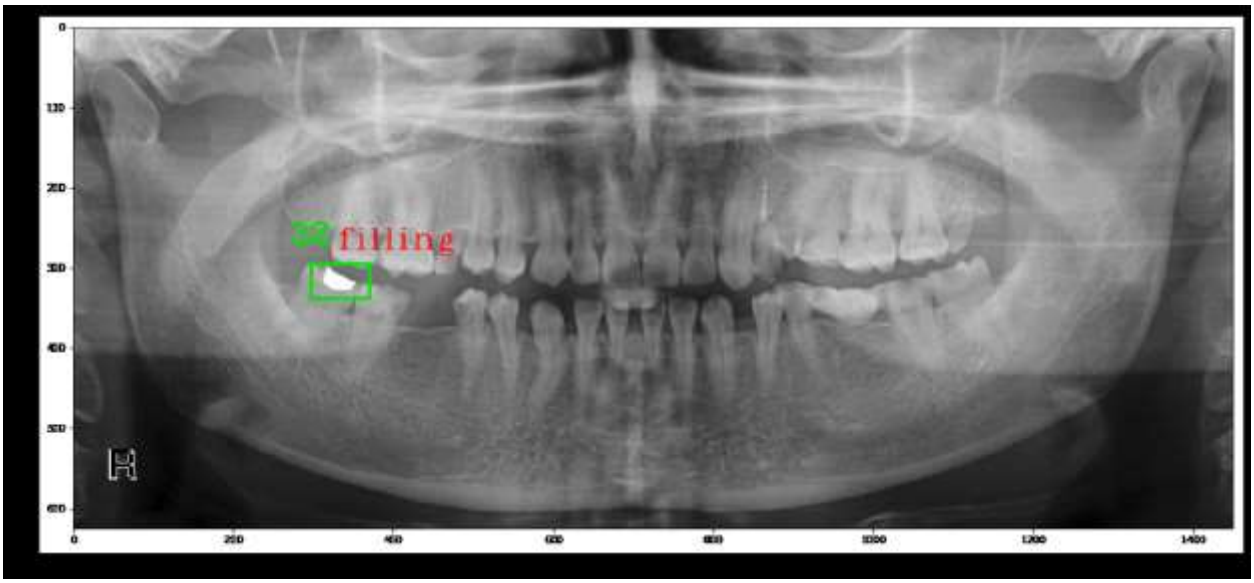


Figure 2: Teeth numbering for a tooth with filling

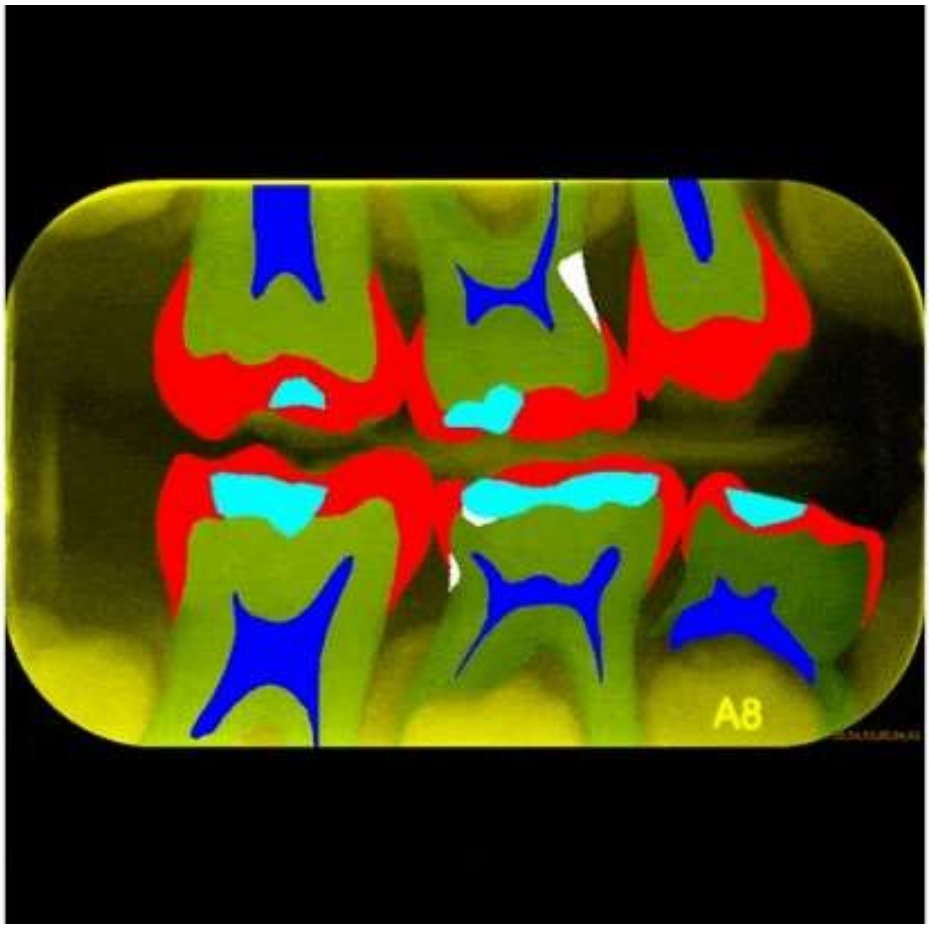


Figure 3: Colour code based on density of the Dental X-ray

Conclusion

These proposed system hence significantly reduce the workload of human experts. Computerized automatic dental radiography analysis systems for clinical use save time and manual costs and avoid problems caused by intra-and inter-observations e.g. due to fatigue, stress or different levels of experience.

Future Enhancements

More types of neural networks and architectures should be tested in future research and a better method might be obtained to improve the teeth detection results. Also in order to help doctor we can add an extra feature to diagnose further dental problems and prescribe a treatment as a suggestion. Prediction of missing tooth can also be added as an improvement.