Detection of Periapical Lesions on Panoramic Radiographs Using Deep Learning

جامعة قطر QATAR UNIVERSITY الصحة HEALTH

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Background

Apical periodontitis is the consequence of root canal system infection by bacteria that is manifested as periapical bone resorption. The periapical bone resorption is developed as a response to the host's defense against bacterial infection (Gazivoda et al 2009). It affects about 33 to 62 % of the adult population and it can have detrimental effects on both oral and systemic health (Tibúrcio-Machado et al 2021).

While the diagnosis of acute apical periodontitis is performed clinically, the detection of chronic apical periodontitis is made by radiographs used to reveal characteristic periapical radiolucencies that are usually called apical lesions (Patel and Durack 2019).

Dentists could sometimes fail to notice periapical lesions while examining panoramic radiographs. This could have implications on patients' well-being and dentists' liability. The development of artificial intelligence (AI) for detection of periapical lesions in panoramic radiographs could help avoid these problems.

Aim

- General aim: The aim of this study is to develop an Artificial intelligence tool (AI) for the detection of periapical lesions on panoramic radiographs.
- Specific aims:
  1. Annotation of Panoramic radiographs for the machine learning
  2. Development of an algorithm for detecting the periapical area (healthy or with periapical lesion)
  3. Development of an algorithm for classifying the periapical area (healthy or with periapical lesion)
  4. Assessment of the performance of the algorithm

Methodology

Data preparation

- 713 panoramic radiographs with total of 18618 Periapical root areas (PRA) were annotated as: having PA (unhealthy) or not having PA (healthy)
- Annotation was done by 2 independent-examiners in duplicate; discrepancies between examiners were settled by a third examiner.

Figure 1: Annotating the periapical lesions

Proposed Model

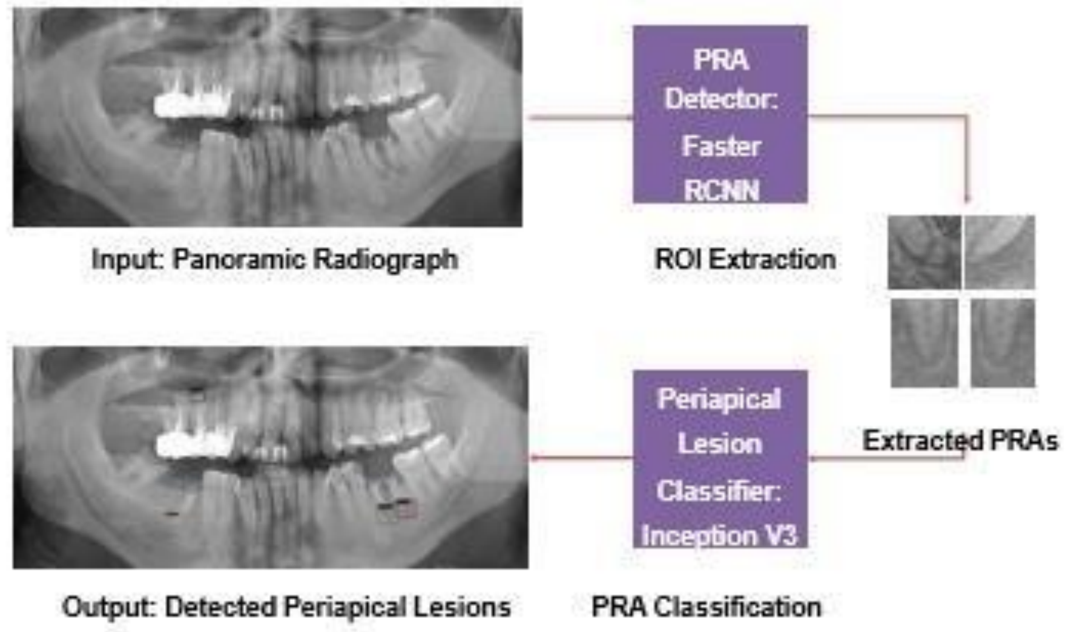

Figure 2: System Architecture

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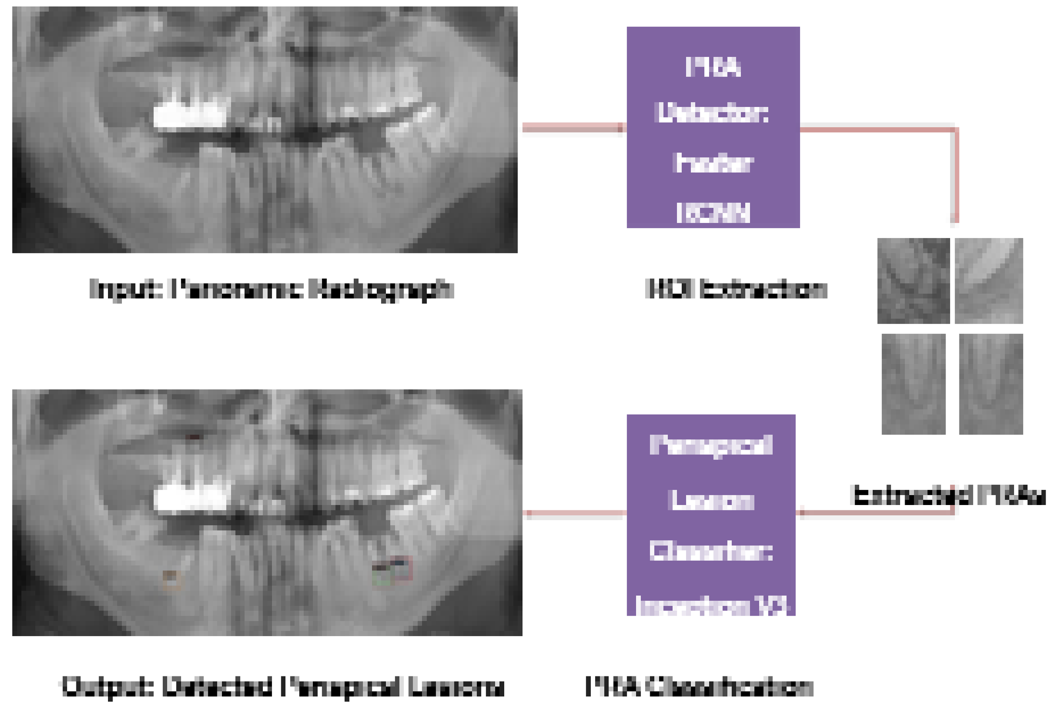

Figure 2: System Architecture

Results

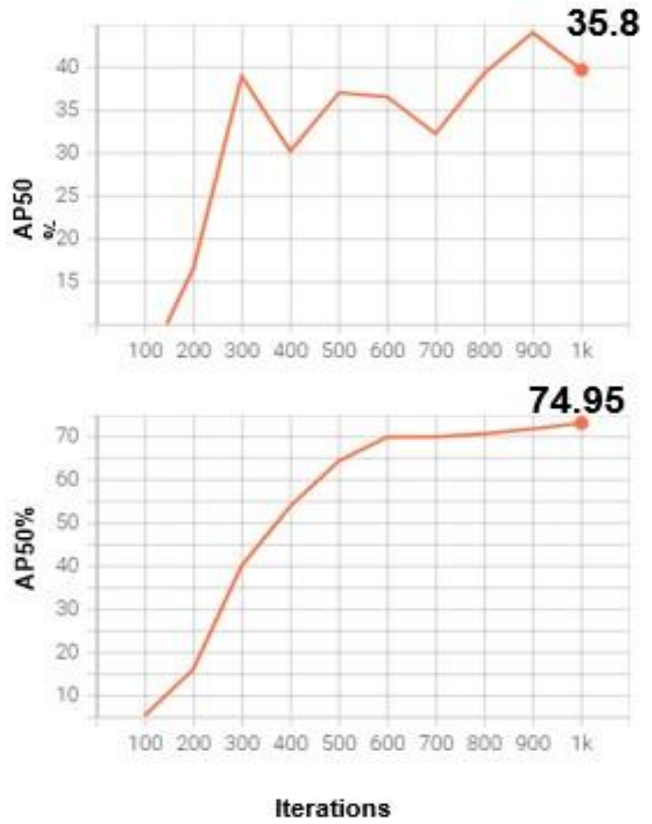

Figure 3: Average Precision calculated at Intersection-over-Union (IoU) of 0.5 (AP50)

Table 1: Evaluation of the Tested Classification Models

Metric	Inception v3	VGG16	Xception
Accuracy	82%	79%	78%
Sensitivity	86%	76%	77%
Specificity	79%	82%	79%

Table 2: The overall performance of the proposed method

Accuracy	Sensitivity	Specificity
84.6	72.2%	85.6%

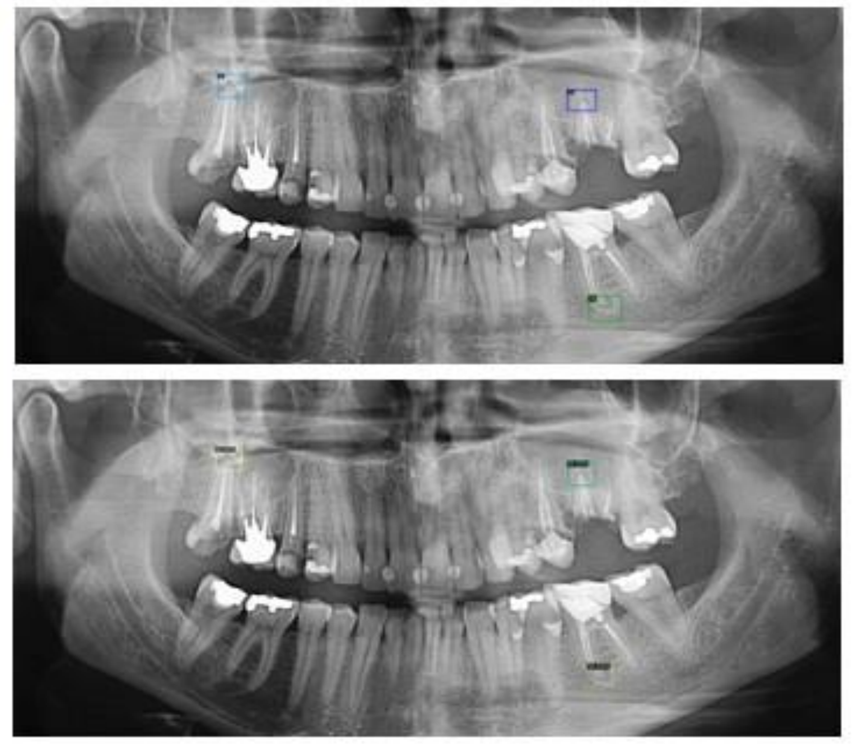

Figure 4: Example of the detected periapical lesions. First: Groundtruth, Second: AI Output

Conclusion

Experimental results show the effectiveness of the proposed method to detect periapical lesions on panoramic radiographs.

References

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- Tibúrcio-Machado, C.S., Michelon, C., Zanatta, F.B., Gomes, M.S., Marin, J.A. and Bier, C.A., 2021. The global prevalence of apical periodontitis: a systematic review and meta-analysis. International endodontic journal, 54(5), pp.712-735.
- Patel, S. and Durack, C., 2019. Radiology of Apical Periodontitis. Essential Endodontology: Prevention and Treatment of Apical Periodontitis, pp.179-210.

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