# 論文の内容の要旨

論文題目「Study on Caries Detection from Dental Panoramic Radiographs using Deep Learning」
（深層学習を用いた歯科パノラマレントゲン画像からのう蝕歯検出に関する研究）

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キーワード：caries, panoramic radiograph, tooth isolation, deep learning, image processing.

Caries is one of the most well-known diseases that affect billions of lives around the world. Most people experienced at least one or several symptoms such as tooth pain, halitosis, and eventually result in tooth removal. There are many methods to evaluate damages from caries, and among them, dentists prefer staging to C0, C1, C2, C3, C4. While C0 presents a healthy tooth, C1 to C4 presents different stages of caries which lead to different conditions and treatments. Caries treatment is mostly expensive without an early diagnosis and therefore leads to financial burdens; especially in the under-developing country where usually lacks people's awareness of dental hygrines and experienced dentists. As a result, the purpose of this study is to propose a method that provides early caries detection to support a dentist.

Computer-assisted diagnosis (CAD) is a branch of artificial intelligence and computer science. The purpose of CAD is to enable electronic devices to observe, interpret relevant data, and produce a suitable output that can assist humans in making decisions. Machines have improved in terms of convenience and power as technology advances. Therefore, machines may be able to take over a variety of functions previously performed by people. Nowadays, many computer-vision studies prefer to employ image processing techniques and machine learning algorithms to solve different problems, since the combinations between them can partially reduce the complexity by learning without being programmed to perform a specific task but still providing an effective result based on requirements. In machine learning, neural networks are well-known techniques which are widely used to solve pattern recognition problems. Neural networks are simple to construct and often appear to be good ability to generalize and respond to unexpected patterns. For that season, this study applies the image processing and deep learning based on neural network as the main methods in CAD.

Despite the fact that some researchers have sought to remedy this issue, the majority of them are either very complex, needing a huge load of resources and incurring a significant computational burden, or overly simplistic and incapable of producing an adequate outcome. Therefore, my proposed

approach streamlined the most complex processes while keeping the benefits of each component. The CAD system mainly focuses on two processes: tooth isolation and caries detection. Firstly, in tooth isolation, the position of each tooth is detected in a panoramic radiograph using the YOLOv3 model. The original oral images will be resized and fed into the YOLOv3 to split out to several individual tooth images which is useful for centralized diagnosis later. The process can help reducing a huge workload of dentists and nurses, and play an important role in speeding up the diagnosis. On the other hand, the manual isolation of tooth images is fed to a deep convolutional neural network for caries diagnosis. The useful features from the images are extracted using geometry and pre-trained deep learning model, such as Resnet50, Xception, VGG16, ...etc., and fed into other machine learning models such as decision trees, naive Bayes, k-nearest neighbor, and support vector machine for the final diagnosis. On tooth isolation, the final result shows 95.58%, 94.90% for precision and recall, respectively. And on caries detection, the final result shows 91.70%, 90.43%, and 92.67% for accuracy, sensitivity, and specificity. The results are better, or equivalent compared with the previous researches. Finally, the caries detection system is also tested on the automatic isolation tooth for a comprehensive assessment. The final results slightly reduce compared to caries detection using manual isolation and reach to 88.66%, 88.14%, and 89.47% for accuracy, sensitivity, and specificity, respectively. However, an automatic caries detection system which can conduct tooth isolation and caries detection has not been proposed and the reductions are small; therefore, the proposal and evaluation of the automatic caries detection system is important and contribute to the field of dental diagnosis.

The research's objectives were well accomplished in terms of tooth isolation and caries detection. The tooth was found automatically in the oral panoramic radiography utilizing an automated isolation tooth technique. Precision demonstrates a high level of detection accuracy; as a result, the procedure is advantageous and practical for a dentist. All facets of the matter seem to have been considered. However, the method may be greatly enhanced. The outcome of manual tooth isolation has surpassed the prior state-of-the-art in caries detection. Increased specificity demonstrates that the dataset and its results are balanced, consistent, and dependable. On the other side, the automated combination technique results in a modest decrease in total caries detection. However, this automatic system is a new proposal in the field of dental diagnosis and the reduction is small; therefore, the system can contribute to the field of dental diagnosis. The weak may be identified by the automated isolation tooth system's relativity. As a result, it could be recognized as a benefit to get a further understanding of the disease's diagnosis in general.