



# Prediction Of Dental Implants Using Machine Learning Algorithms

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**Abstract:** According to some, artificial intelligence (AI) and Machine Learning has the potential to revolutionize the healthcare industry by fostering increased productivity and novel approaches to the provision of healthcare services. Recently, corporations, the government, and the private sector in general, and the health industry in particular, have made a significant shift towards machine learning. Dentistry demands cutting-edge techniques that benefit both the client and the provider of the service in order to receive the best and most appropriate medical care. Through early diagnosis and case prediction of dental implant cases, artificial intelligence has the potential to advance the field of dentistry. In order to forecast when a patient would require dental implants, this research creates a collection of four machine learning algorithms. The Bayesian network, random forest, AdaBoost algorithm, and enhanced AdaBoost algorithm are among these models. Analysis of the results shows that the machine learning system is performing well

**Index Terms** - dental implants, machine learning, dentistry, ml in dental

## I. INTRODUCTION

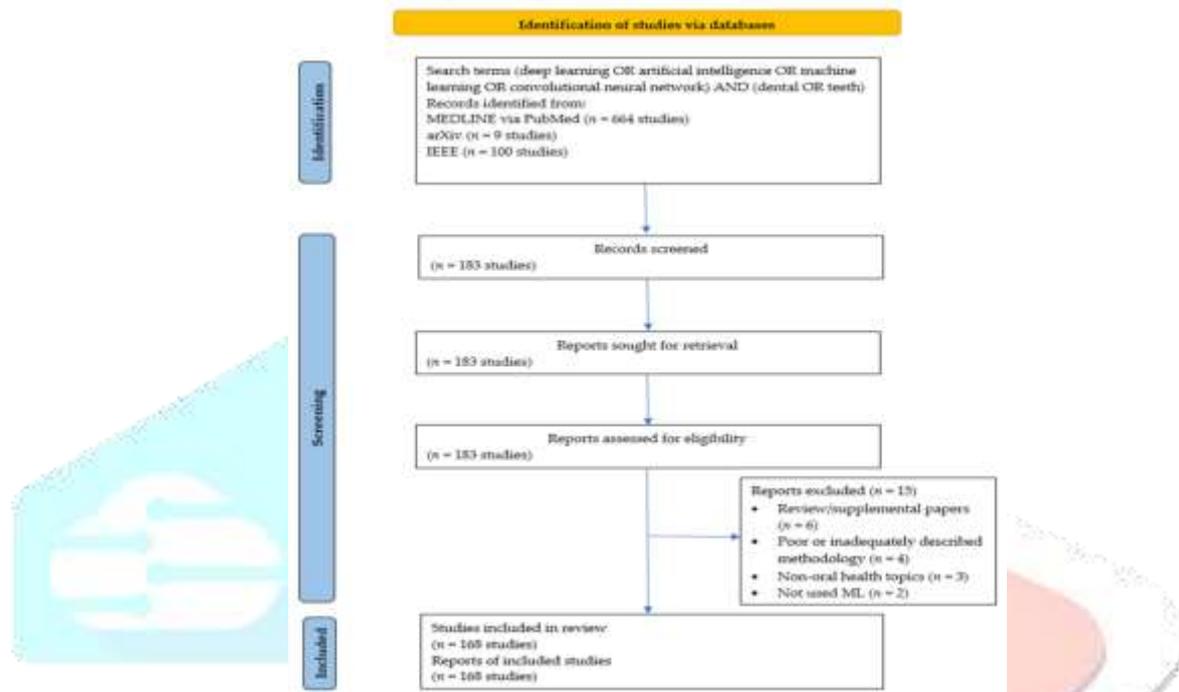
A wide range of industries have used AI in their processes. The use of artificial intelligence in healthcare has significantly increased during the last few years, with encouraging results. Dental implants and human biology are just two examples of the healthcare industries where artificial intelligence (AI) has already been used.

In a dental clinic, it's crucial to employ technology that keeps prices down while helping to improve quality. Otherwise, a misdiagnosis might lead to high-cost legal action, raising the dental clinic's costs. The Bayesian machine learning algorithm was developed as a new method for diagnosing and treating dental caries. A Bayesian network is made to enhance decision-making when comparing various treatment options. By employing this technique, the dentist can treat patients with greater assurance and perform better overall. For tackling such issues, the Bayesian network offers a solid mathematical foundation.

This study helps doctors quickly identify patients who might benefit from dental implants. There may be a very long waiting list for people seeking dental implants due to the overcrowding in public hospitals and private clinics. As a result, it is necessary to design a proposal for a scientific study utilizing artificial intelligence.

The primary contributions of the current work include the use of four machine learning algorithms, including the Bayesian network, random forest, AdaBoost algorithm, and modified AdaBoost algorithm, to predict which patients are likely to require dental implants based on historical data and present-day symptoms. In a graph, the efficacy of each algorithm is displayed.

Early disease prediction has benefited both directly and indirectly from machine learning uses of data complexity and variety. One of the most fatal diseases, for instance, is heart disease. Researchers from all across the world are using information from patients with heart disease to forecast or predict the condition and, as a result, avert the untimely death of countless people. Tasks requiring classification and prediction benefit from the use of machine learning methods.



**Figure 1: Role of Machine Learning in Dental Implants**

## II LITERATURE REVIEW

In some instances, a dentist is unable to resolve a patient's implant-related issues because they are unfamiliar with the implant system. As a result, a system that can determine a patient's implant system from a little amount of data and is independent of the dentist's training and expertise is required. This study's goal was to recognize dental implant systems through deep learning.

The findings of this work demonstrate that utilizing deep learning-based object detection, implants can be recognized from panoramic radiography pictures. This identification approach can be useful for both dentists and patients with implant-related issues. To improve learning performance and use of this system in clinical practice, further photos of various implant systems will be required [1].

According to some, artificial intelligence (AI) has the potential to revolutionize the healthcare industry by fostering increased productivity and novel approaches to the provision of healthcare services. Recently, corporations, the government, and the private sector in general, and the health industry in particular, have made a significant shift towards artificial intelligence. Numerous studies have shown that artificial intelligence is making a significant contribution to the healthcare industry by identifying disorders and choosing the most effective therapies for patients [2].

Applications of artificial intelligence (AI) in dental implant treatments are expanding. In implant dentistry applications, the present growth and effectiveness of AI models have not yet been carefully recorded and analyzed.

With regard to implant type recognition, implant success prediction using patient risk factors and ontology criteria, and implant design optimization combining AI models and finite element analysis (FEA) calculations, the aim of this systematic review was to evaluate the performance of AI models in implant dentistry. Although still under development, AI models for implant type recognition, success prediction, and design optimization

have shown considerable promise. The development and evaluation of the clinical performance of AI models for the implant dentistry applications under consideration require additional research, which is essential. [5].

To ensure effective care, it is essential to correctly identify dental implant brands and the stage of the procedure. Therefore, the aim of this study was to investigate a classifier that classifies implant brands and treatment phases from dental panoramic radiography pictures using multi-task deep learning. Digital panoramic radiographs of patients who underwent treatments at Kagawa Prefectural Central Hospital, Japan, between 2005 and 2020 were used to obtain 9767 dental implant pictures of 12 implant brands and treatment stages for objective labelling. Five deep convolutional neural network (CNN) models were assessed.

According to our analysis, both classifications performed better when there were more factors and a deeper network. All performance measures, with the exception of recall, and all metrics in the classification of the therapy phase were greatly enhanced by multitasking. The classification of dental implant brands and treatment stages was highly valid when CNNs were used. Additionally, accuracy of analysis was facilitated by multitask learning [10].

In the context of recognizing dental implants, a unique technique for producing synthetic training samples from triangulated three-dimensional (3D) surface models is put forth. The suggested approach is based on computing two-dimensional (2D) projections of three-dimensional (3D) volumetric representations of CAD surface models from various angles. The goal is to automatically identify the connection type associated with a specific dental implant in an actual X-ray image by training a fully convolutional network (FCN) using artificially produced X-ray images. For the purpose of separating questioned dental implants from the backdrop in actual X-ray images, semi-automatic and completely automated techniques are suggested.

The above-mentioned results are particularly encouraging because the suggested methods make use of a group of techniques that have never before been used to classify or recognize dental implants [12].

Dental implants have become increasingly important in daily dental offices. The degree of pain and discomfort experienced during a surgical procedure varies from one patient to another. Using advanced machine learning algorithms to predict pain, the dentist and the patient would make more informed decisions about the treatment. This study aims at Predicting postoperative discomfort using an AI-based multi-linear regression model. The functional parametric association between the eight parameters (age, sex, and operating technique) and the patient's postoperative pain was established following implant surgery. The output was normalized information regarding both incidence and severity of immediate discomfort post-implant surgery.

Finally, the clinical viability and effectiveness of this AI model in predicting postoperative pain following surgery were demonstrated [15].

A generic phrase used to describe the development of computer systems that can carry out functions that typically require human intellect is artificial intelligence (AI). A branch of artificial intelligence called machine learning (ML) uses computers to learn rules from data and recognize its inherent statistical patterns and structures. For ML complicated data, neural networks (NNs) have been used more and more. "Deep learning" is the application of multilayered NN, which has lately been researched in dentistry. Using layers of filters, convolutional neural networks (CNNs) are able to extract picture elements including edges, corners, forms, and macroscopic patterns, making them particularly useful for processing big and complicated images data. Tasks like picture categorization, object detection, and segmentation are possible with CNN algorithms.

However, an obstacle to practical dental AI continues to be the minimal contact between the technical disciplines and the dentistry industry. Similar to other users, dental users must comprehend why and how AI programmes function in order to critically evaluate their choices. Applications of robust and generalizable AI will eventually be beneficial to both patients and clinicians [17].

Deep learning (DL) has a bright future in computer vision applications and is ideally suited for dental image analysis and recognition. Using dental imaging, we assessed the precision of DL algorithms in recognizing and categorizing dental implant systems (DISs). We searched the MEDLINE/PubMed, Scopus, Embase, and Google Scholar databases for studies published between January 2011 and March 2022 for this systematic review and meta-analysis. The accuracy of the DL models was assessed using panoramic and periapical radiographic images from studies on DL techniques for DIS detection or classification.

In classifying and recognizing DISs from panoramic and periapical radiography images, DL models demonstrated good accuracy. As a result, DL models have great promise for usage as tools for aiding in decision-making; yet, there are restrictions on how they may be used in actual clinical settings [18].

Failure of a dental implant is a dangerous condition that can seriously impair the effectiveness of treatment. Implant failure has been linked to inadequate bone volume, poor bone quality, periodontal bone loss, and systemic diseases such as osteopenia/osteoporosis and diabetes mellitus. Potential implant failure early warning signs may reduce the risk of serious consequences. The goal of this study was to create a reliable implant outcome prediction model using dental panoramic and periapical films

The deep learning model could help with early clinical intervention for suspected dental implant failures by efficiently predicting the occurrence of implant failure using features from periapical and panoramic pictures. [19].

Dental implant (DI) fracture is a mechanical problem that is uncommon but has a significant impact on DI failure and explanation. In order to detect and classify fractured DI using panoramic and periapical radiographic images, this study aimed to assess the validity and reliability of three different deep convolutional neural network (DCNN) architectures (VGGNet-19, GoogLeNet Inception-v3, and automated DCNN). Two dental hospitals examined 21,398 DIs in total. Of those, 251 intact and 194 broken DI radiographic pictures were found and included in the dataset for this investigation.

The automated DCNN design using only periapical pictures demonstrated the highest accuracy performance among the three DCNN architectures in the detection and categorization of fractured DIs [20].

### III. CONCLUSION

In this research work we reviewed many papers on machine learning application for dental implants.

In order to forecast the need for dental implants, this study introduces four machine learning algorithms that collect patient diagnoses and import the data to the technology. As a result, the suggested model in this research uses machine learning technology to anticipate when patients could need dental implants based on the patients' historical data and present symptoms. We think that by focusing on patients with certain diseases, this plan will help dentists and decision-makers.

The empirical comparison demonstrated here demonstrates that the upgraded AdaBoost algorithm provides more accuracy. Such an improvement in sound judgment may lower the likelihood of dental implant issues. The foundation of our suggestion is the refinement of the sample weights initialization parameter. The scientific community benefits from this discovery. In fact, instead of initializing the sample weights AdaBoost with a value set ad hoc to the uniform distribution, we advise using a more effective iterative procedure. In conclusion, it seems that the AdaBoost algorithm is particularly noise-sensitive. As a result, taking into account the ideal initialization sample weights that ought to be connected to a given dataset definitely influences the prediction performance of this approach.

### IV. ACKNOWLEDGMENT

I would like to acknowledge the Department of CSE at AITS for helping in the development of the review paper. They also made resources easily accessible and also helped in the deployment at the final stage.

### REFERENCES

- [1] G. Eason, B. Noble, and I. N. Sneddon, "On certain integrals of Lipschitz-Hankel type involving products of Bessel functions," *Phil. Trans. Roy. Soc. London*, vol. A247, pp. 529–551, April 1955. (*references*)
- [2] J. Clerk Maxwell, *A Treatise on Electricity and Magnetism*, 3rd ed., vol. 2. Oxford: Clarendon, 1892, pp.68–73.
- [3] I. S. Jacobs and C. P. Bean, "Fine particles, thin films and exchange anisotropy," in *Magnetism*, vol. III, G. T. Rado and H. Suhl, Eds. New York: Academic, 1963, pp. 271–350.
- [4] K. Elissa, "Title of paper if known," unpublished.
- [5] R. Nicole, "Title of paper with only first word capitalized," *J. Name Stand. Abbrev.*, in press.

- [6] Y. Yorozu, M. Hirano, K. Oka, and Y. Tagawa, "Electron spectroscopy studies on magneto-optical media and plastic substrate interface," *IEEE Transl. J. Magn. Japan*, vol. 2, pp. 740–741, August 1987 [Digests 9th Annual Conf. Magnetism Japan, p. 301, 1982].
- [7] M. Young, *The Technical Writer's Handbook*. Mill Valley, CA: University Science, 1989.
- [8] Takahashi, Toshihito, et al. "Identification of dental implants using deep learning—pilot study." *International journal of implant dentistry* 6 (2020): 1-6.
- [9] Alharbi, Mafawez T., and Mutiq M. Almutiq. "Prediction of Dental Implants Using Machine Learning Algorithms." *Journal of Healthcare Engineering* 2022 (2022).
- [10] Sukegawa, Shintaro, et al. "Multi-task deep learning model for classification of dental implant brand and treatment stage using dental panoramic radiograph images." *Biomolecules* 11.6 (2021): 815.
- [11] Kumar, Anish, et al. "Investigation of biocompatible implant material through WEDM process using RSM modeling hybrid with the machine learning algorithm." *Sādhanā* 46.3 (2021): 148.
- [12] Kohlakala, Aviwe, et al. "Deep learning-based dental implant recognition using synthetic X-ray images." *Medical & Biological Engineering & Computing* 60.10 (2022): 2951-2968.
- [13] da Mata Santos, Rafael Pereira, et al. "Automated Identification of Dental Implants Using Artificial Intelligence." *International Journal of Oral & Maxillofacial Implants* 36.5 (2021).
- [14] Kurt Bayrakdar, Sevda, et al. "A deep learning approach for dental implant planning in cone-beam computed tomography images." *BMC Medical Imaging* 21.1 (2021): 86.
- [15] Yadalam, Pradeep Kumar, et al. "Machine Learning Predicts Patient Tangible Outcomes After Dental Implant Surgery." *IEEE Access* 10 (2022): 131481-131488.
- [16] Alsomali, Mona, et al. "Development of a deep learning model for automatic localization of radiographic markers of proposed dental implant site locations." *The Saudi Dental Journal* 34.3 (2022): 220-225.
- [17] Rodrigues, Jonas Almeida, Joachim Krois, and Falk Schwendicke. "Demystifying artificial intelligence and deep learning in dentistry." *Brazilian Oral Research* 35 (2021).
- [18] Chaurasia, Akhilanand, et al. "Deep-learning performance in identifying and classifying dental implant systems from dental imaging: a systematic review and meta-analysis." *Journal of Periodontal & Implant Science* 53 (2023).
- [19] Zhang, Chunan, et al. "Deep learning based dental implant failure prediction from periapical and panoramic films." *Quantitative Imaging in Medicine and Surgery* 13.2 (2023): 935.
- [20] Lee, Dong-Woon, et al. "Artificial intelligence in fractured dental implant detection and classification: evaluation using dataset from two dental hospitals." *Diagnostics* 11.2 (2021): 233.