

# Capturing Precision: The Growing Role of Photogrammetry in Implant Dentistry"

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**ABSTRACT:** Photogrammetry is a powerful tool in implantology that can improve the accuracy and efficiency of implant placement. By creating accurate 3D models of a patient's mouth and teeth, dentists can plan implant placement with a high degree of precision and ensure better outcomes for patients. As technology continues to advance, we can expect to see even more applications of photogrammetry in the field of dentistry, leading to better outcomes and a more comfortable experience for patients. Photogrammetry technology has become increasingly popular in implant dentistry due to its non-invasive nature and ability to produce accurate 3D models of the oral cavity.

**Key Words:** Photogrammetry, AI.

**Key Message:** Photogrammetry technology is a reliable and accurate method for capturing data in implant dentistry. While there are some limitations, the advantages of photogrammetry technology make it a valuable tool in implant planning, placement, and prosthesis design. Further research is needed to fully evaluate the potential of this technology in implant dentistry.

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## I. INTRODUCTION

In the field of dentistry, implantology has become one of the most advanced and effective ways of replacing missing teeth. One of the most important aspects of implantology is the accuracy of the implant placement, which can significantly affect the success of the procedure. In recent years, photogrammetry has emerged as a powerful tool for ensuring the accuracy of implant placement. Photogrammetry is a non-invasive technique that uses photographs to create 3D models of objects or surfaces. In this article, we will explore the use of photogrammetry in implantology and how it can improve the accuracy of implant placement.

### What is Photogrammetry?

Photogrammetry is a technique that uses photographs to create 3D models of objects or surfaces. The process involves taking multiple photographs of an object or surface from different angles and using software to combine these images into a 3D model. The resulting model can be used to measure distances, angles, and other parameters, making it a powerful tool in a variety of applications.

### Photogrammetry in Implantology

In implantology, photogrammetry is used to create accurate 3D models of a patient's mouth and teeth. These models can be used to plan the placement of dental implants with a high degree of accuracy. There are several benefits to using photogrammetry in implantology.

**Non-invasive:** Photogrammetry is a non-invasive technique that does not require any incisions or invasive procedures. This makes it a safer and less painful alternative to traditional methods of implant placement.

**Accurate:** Photogrammetry is a highly accurate technique that can produce 3D models with a high level of precision. This allows for more accurate implant placement and better outcomes for patients.

**Efficient:** Photogrammetry is a fast and efficient technique that can produce 3D models in a matter of minutes. This reduces the amount of time patients need to spend in the dentist's chair and can lead to quicker recovery times.

### How Photogrammetry Works in Implantology

The process of using photogrammetry in implantology involves several steps:

**Capturing Images:** The first step in using photogrammetry in implantology is to capture images of the patient's mouth and teeth. This is typically done using a digital camera or a specialized intraoral scanner.

**Creating a 3D Model:** Once the images have been captured, they are processed using software to create a 3D model of the patient's mouth and teeth. The software uses algorithms to analyze the images and create a 3D model

that accurately represents the patient's anatomy.

**Planning Implant Placement:** Once the 3D model has been created, the dentist can use specialized software to plan the placement of dental implants. The software allows the dentist to visualize the placement of the implants and ensure that they are placed in the optimal position for stability and function.

**Fabricating the Restoration:** Once the implants have been placed, the 3D model can be used to create a custom restoration that fits perfectly in the patient's mouth. This can include a crown, bridge, or denture that is designed to look and function like natural teeth.

There have been several studies conducted on the use of photogrammetry in implant dentistry, which have shown promising results. Here are a few examples:

A study published in the *Journal of Prosthetic Dentistry* in 2017 evaluated the accuracy of photogrammetry in the fabrication of implant-supported prostheses. The study found that photogrammetry was a reliable and accurate method for capturing the implant position and the soft tissue contours, with an accuracy rate of 0.11 mm.

Another study published in the *International Journal of Oral and Maxillofacial Implants* in 2016 compared the accuracy of photogrammetry with that of CBCT scans in implant planning. The study found that photogrammetry was able to capture accurate 3D models of the oral cavity and implant sites, with an accuracy rate of 0.31 mm, which was comparable to the accuracy of CBCT scans.

A study published in the *Journal of Indian Prosthodontic Society* in 2016 evaluated the use of photogrammetry in implant-supported prosthesis fabrication for a patient with a partially edentulous maxilla. The study found that photogrammetry was able to accurately capture the implant position and soft tissue contours, allowing for the fabrication of a precise implant-supported prosthesis.

Overall, these studies suggest that photogrammetry is a reliable and accurate method for capturing data in implant dentistry, and has several advantages over traditional methods. Further research is needed to fully evaluate the potential of this technology in implant dentistry.

### **Artificial intelligence (AI) and Photogrammetry**

AI is increasingly being integrated with photogrammetry technology to improve its accuracy and efficiency. Here are some ways in which AI is being used in photogrammetry:

**Automated Feature Extraction:** AI algorithms can be used to automatically identify and extract features from photogrammetry models. This can reduce the time required for manual feature extraction and improve the accuracy of the models.

**Object Recognition:** AI algorithms can be used to recognize specific objects or features in photogrammetry models. This can be particularly useful in implant dentistry, where AI can be used to automatically identify the position and orientation of dental implants in the 3D model.

**Quality Control:** AI can be used to automatically detect errors and inconsistencies in photogrammetry models. This can improve the accuracy and reliability of the models, and reduce the need for manual quality control.

**Prediction and Simulation:** AI algorithms can be used to predict the behavior of objects in the photogrammetry model, such as the movement of soft tissue during chewing or speaking. This can be used to simulate the performance of dental implants and other prosthetic devices in different scenarios, and optimize their design and placement.

Overall, the integration of AI with photogrammetry technology has the potential to significantly improve the accuracy and efficiency of data capture in implant dentistry and other fields. As AI technology continues to advance, we can expect to see even more innovative applications of this technology in photogrammetry and other areas of dentistry.

The future of photogrammetry looks promising, with advances in technology and software enabling more efficient and accurate data capture. Here are some potential developments in the field of photogrammetry:

**Improved Sensors:** Advances in sensor technology, such as higher resolution cameras and LiDAR sensors, will enable more accurate and detailed data capture in photogrammetry.

**Cloud-based Processing:** Cloud-based photogrammetry processing can help overcome the limitations of processing power and storage capacity of local computers, making it easier and faster to generate 3D models from large datasets.

**Integration with AI:** As mentioned earlier, the integration of AI algorithms with photogrammetry technology can significantly improve accuracy and efficiency, and we can expect to see more sophisticated AI applications in the future.

**Real-time Visualization:** Real-time visualization of photogrammetry models can enable clinicians to make more informed decisions during implant planning and surgery. This technology can also be used to educate patients about their treatment options and visualize the potential outcomes of their treatment.

**Augmented Reality:** The integration of photogrammetry with augmented reality (AR) technology can enable clinicians to overlay virtual models onto the real world, allowing them to visualize the implant placement and

prosthesis design in the patient's mouth in real time.

Overall, the future of photogrammetry in implant dentistry and other fields looks bright, with the potential for more efficient and accurate data capture, as well as innovative applications of AI, cloud processing, real-time visualization, and AR technology.

### **Pros of Photogrammetry**

**High Accuracy:** Photogrammetry can produce highly accurate 3D models and measurements, which is particularly useful in dental implant planning and surgery.

**Cost-Effective:** Photogrammetry can be a cost-effective alternative to other imaging modalities, such as CT scans or MRI.

**Non-Invasive:** Photogrammetry is non-invasive, which means there is no radiation exposure, making it a safer imaging option for patients.

**Versatility:** Photogrammetry can be used to capture data in various settings, including intraoral, extraoral, and extra-oral full-face scans.

**Portability:** Photogrammetry equipment is generally portable, allowing clinicians to capture data on-site or in the field.

### **Cons of Photogrammetry**

**Limited Depth Perception:** Photogrammetry can have limited depth perception compared to other imaging modalities, which can impact accuracy in certain cases.

**Image Quality:** The accuracy of photogrammetry depends on the quality of the images captured, and poor image quality can result in inaccurate measurements.

**Technical Expertise:** Photogrammetry requires technical expertise to capture and process data accurately, which can be a limiting factor for some clinicians.

**Equipment Cost:** The cost of photogrammetry equipment can be a significant investment, particularly for small dental practices.

**Regulatory Environment:** The regulatory environment for photogrammetry is still evolving, and it is important to comply with the applicable regulations and standards for data privacy and security.

## **COSTING OF PHOTOGRAMMETRY**

The cost of photogrammetry varies depending on several factors, such as the equipment used, the complexity of the project, and the level of expertise required. Here are some cost factors to consider:

**Equipment Costs:** The cost of photogrammetry equipment can range from a few hundred dollars for a basic digital camera and software, to several thousand dollars for high-end cameras and LiDAR sensors.

**Processing Costs:** Photogrammetry software can range from free or low-cost options, to high-end software with advanced features that can be quite expensive. Some software also requires a subscription fee or license.

**Expertise and Training Costs:** The expertise and training required to capture and process high-quality photogrammetry data can be a significant cost factor. This includes the cost of hiring a trained photogrammetry specialist, or investing in employee training and certification.

**Project Complexity:** The cost of photogrammetry can also vary depending on the complexity of the project. For example, a simple implant case may require only a few basic photographs, while a full-mouth rehabilitation may require more advanced equipment and software, as well as additional time and expertise.

Overall, the cost of photogrammetry can range from a few hundred dollars for a simple project, to several thousand dollars for a more complex project requiring advanced equipment and expertise. It is important to carefully consider the costs and benefits of photogrammetry when deciding whether to incorporate this technology into your dental practice.

## **II. CONCLUSION**

Photogrammetry has several advantages in implant dentistry, including high accuracy, cost-effectiveness, non-invasiveness, versatility, and portability. However, there are also some limitations to consider, such as limited depth perception, image quality, technical expertise, equipment cost, and regulatory compliance.

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### **Conflicts of interest**

There are no conflicts of interest.

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