# Smile Photograph Analysis as One of the Identification Methods in Forensic Anthropology and Odontology

## Padhi S[1]*, Panigrahi A[2] and Biswal KK[3]

[1]Department of Psychology, Gangadhar Meher University, India
[2]Department of Forensic Science, Lovely Professional University, India
[3]Professor cum Principal, Saltora Netaji Centenary College, India

**Corresponding author:** Sanjukta Padhi, Head of the Department, School of Psychology, Gangadhar Meher University, Sambalpur, Odisha, India, Tel: 7978706852; Email: spsanjuktapadhi@gmail.com

## Abstract

Smile photograph analysis is one of the identification methods used in forensic anthropology and odontology, and it can be a useful tool in identifying individuals. The analysis of a smile photograph involves examining the unique characteristics of an individual's smile, such as the shape of their teeth, the spacing between teeth, and the size and shape of their lips. In forensic anthropology, smile photograph analysis can be used to help identify individuals who are missing or are deceased. This method can be particularly useful in cases where there is no other means of identification, such as when the body is badly decomposed or damaged. By comparing a smile photograph of a missing or deceased person to photographs of known individuals, forensic anthropologists can often make a positive identification. This research evaluates the comparison and identification efficiency of this method when applied to photographs of an individual in different stages of life.

## Introduction

Forensic anthropology: is a branch of forensic science that involves the examination and analysis of human skeletal remains to determine information about the individual and the circumstances surrounding their death. Forensic anthropologists use their knowledge of human anatomy, biology, and behaviour to interpret skeletal evidence and provide information to law enforcement agencies, medical examiners, and coroners [1].

The primary goal of forensic anthropology is to help identify human remains, which may be found in a variety of contexts, including crime scenes, mass disasters, and archaeological sites. By analysing skeletal remains, forensic anthropologists can determine the age, sex, ancestry, and stature of the individual, as well as any injuries or abnormalities that may have contributed to their death [2].

Forensic anthropologists also play a key role in determining the cause and manner of death. For example, they may examine skeletal evidence to determine if a person was a victim of homicide, suicide, or accidental death, or if they died from natural causes [3].

Forensic anthropologists often work closely with other forensic specialists, such as forensic odontologists, DNA analysts, and forensic pathologists, to build a complete

picture of the circumstances surrounding a death. They may also be called upon to testify in court as expert witnesses, presenting their findings to judges and juries [4].

Forensic odontology: is a specialized branch of dentistry that deals with the identification of human remains through the examination of teeth and dental records. It involves the application of dental knowledge and expertise to legal issues, primarily in criminal and civil cases.

Forensic odontologists use dental records, including X-rays, dental charts, and photographs, to help identify individuals who are either living or deceased. In cases where human remains are discovered, they can compare dental records to the teeth of the remains to help establish the identity of the deceased.

Forensic odontologists also use their expertise to assist in the investigation of crimes, such as bite mark analysis, where they can examine bite marks on a victim's body to try and identify the perpetrator. They may also be involved in cases of mass disasters, such as airplane crashes or natural disasters, where dental records can be used to identify victims overall, forensic odontology plays an important role in the legal system, helping to identify individuals and bring closure to families of the deceased.

Human identification refers to the process of recognizing and verifying the identity of an individual. There are various methods for human identification, including:
- **Biometric Identification:** This involves using unique physical or behavioural characteristics of an individual, such as fingerprints, facial recognition, iris scan, voice recognition, or DNA analysis, to identify them [5].
- **Identification Documents:** This involves using government-issued identification documents, such as passports, driver's licenses, or ID cards, to verify an individual's identity [6].
- **Knowledge-Based Identification**: This involves verifying an individual's identity based on information they provide, such as answering security questions, providing personal information, or using a PIN or password [7].
- **Physical Identification:** This involves identifying an individual based on their physical appearance, such as recognizing someone by their face or body shape [8].

The method used for human identification often depends on the context and purpose of identification. For example, biometric identification may be used for security purposes, while identification documents may be used for travel or government purposes.

Smile Photograph Analysis involves using artificial intelligence (AI) and machine learning (ML) algorithms to analyze and interpret photographs. This technology can be used to automatically recognize and identify people, objects, and even emotions in photographs.

There are several applications of smile photograph analysis, including:
- **Security:** Facial recognition technology can be used to identify individuals in security footage and track their movements.
- **Marketing:** Companies can use smart photograph analysis to analyse customer photos on social media to gain insights into their preferences and behaviours.
- **Medical:** Smart photograph analysis can be used to detect skin cancer by analysing photographs of moles and lesions.
- **Facial Reconstruction:** using smile photo analysis is a technique that involves using a smile photo of a person to reconstruct their face. This technique is based on the principle that the muscles used to form a smile are the same muscles used to form other facial expressions. By analyzing the structure of the smile, researchers can make predictions about the structure of the face.

The process of facial reconstruction using smile photo analysis typically involves the following steps

## Review of Literature

Silva RF, et al. [9] The paper titled "Forensic Odontology Identification Using Smile Photograph Analysis" aims to explore the use of dental identification methods in forensic investigations by analysing smile photographs of individuals.

The study was conducted on a sample of 20 individuals, with their consent, who were asked to smile for a photograph. The smile photographs were then analysed by a forensic odontologist who identified the individuals based on their dental characteristics. The results of the study showed that the forensic odontologist was able to correctly identify all 20 individuals with a high degree of accuracy. The study also highlighted the importance of dental records in forensic investigations and how they can be used to identify individuals.

Overall, the paper provides valuable insights into the potential use of smile photograph analysis in forensic investigations. However, the sample size of the study was relatively small, which limits the generalizability of the findings. Additionally, further research is needed to explore the feasibility and reliability of using smile photograph analysis in larger-scale forensic investigations [10].

The paper titled "Positive Identification of a Decomposed Human Body through Forensic Anthropology and Smile

Photographs" aims to showcase a case study where forensic anthropology and smile photograph analysis were used to identify a decomposed human body.

The study was conducted on a decomposed human body found in a rural area in Brazil. The body was in an advanced state of decomposition, making it difficult to identify through traditional methods such as fingerprints or DNA analysis. Therefore, the study employed forensic anthropology and smile photograph analysis to identify the individual.

The results of the study showed that the forensic anthropologist was able to determine the age, sex, and height of the individual through skeletal analysis. Additionally, the smile photograph analysis provided valuable information about the dental characteristics of the individual, which were used to make a positive identification.

The paper highlights the importance of forensic anthropology and smile photograph analysis in identifying decomposed human bodies, particularly in cases where traditional identification methods are not feasible. The case study provides a valuable example of how these methods can be used in forensic investigations.

However, it is worth noting that the study is limited to a single case study, and further research is needed to explore the feasibility and reliability of using forensic anthropology and smile photograph analysis in larger-scale forensic investigations. Overall, the paper provides valuable insights into the potential use of these methods in forensic investigations [11].

The study is a case report of a set of skeletonized remains found in a rural area in Brazil. The remains were in an advanced state of decomposition, making it difficult to identify through traditional methods. Therefore, the study employed smile photograph and medical radiograph analysis to identify the individual. The results of the study showed that the smile photograph and medical radiograph analysis were able to provide valuable information about the dental characteristics and medical history of the individual, which were used to make a positive identification. The paper highlights the importance of using multiple identification methods in forensic investigations, particularly in cases where traditional identification methods are not feasible. The case report provides a valuable example of how smile photograph and medical radiograph analysis can be used in forensic investigations to identify skeletonized remains. However, it is worth noting that the study is limited to a single case report, and further research is needed to explore the feasibility and reliability of using smile photograph and medical radiograph analysis in larger-scale forensic investigations. Overall, the paper provides valuable insights into the potential use of

these methods in forensic investigations [12].

The paper titled "Positive Identification of a Decomposed Human Body through Forensic Anthropology and Smile Photographs: A Case Report" presents a case study where forensic anthropology and smile photograph analysis were used to identify a decomposed human body. The study describes a case where a decomposed human body was found in a rural area in Brazil. The body was in an advanced stage of decomposition, and traditional methods of identification such as fingerprints or DNA analysis were not possible. Therefore, the study employed forensic anthropology and smile photograph analysis to identify the individual. The results of the study showed that the forensic anthropologist was able to determine the age, sex, and height of the individual through skeletal analysis. Additionally, the smile photograph analysis provided valuable information about the dental characteristics of the individual, which were used to make a positive identification. The paper highlights the importance of using multiple identification methods in forensic investigations, particularly in cases where traditional identification methods are not feasible. The case report provides a valuable example of how forensic anthropology and smile photograph analysis can be used to identify decomposed human bodies. Overall, the paper demonstrates the potential of forensic anthropology and smile photograph analysis in identifying decomposed human bodies, providing valuable insights into the use of these methods in forensic investigations [13].

The paper titled "The Forensic Value of Smile Photograph and Medical Radiograph Analysis in Identifying Human Skeletonized Remains: A Case Report" presents a case study where smile photograph and medical radiograph analysis were used to identify human skeletonized remains. The study describes a case where skeletonized remains were found in a rural area in Brazil. The remains were in an advanced state of decomposition, making it difficult to identify the individual using traditional methods. Therefore, the study employed smile photograph and medical radiograph analysis to identify the individual. The results of the study showed that the smile photograph and medical radiograph analysis provided valuable information about the dental characteristics and medical history of the individual, which were used to make a positive identification. The paper highlights the importance of using multiple identification methods in forensic investigations, particularly in cases where traditional identification methods are not feasible. The case report provides a valuable example of how smile photograph and medical radiograph analysis can be used to identify skeletonized remains. Overall, the paper demonstrates the potential of smile photograph and medical radiograph analysis in identifying skeletonized remains, providing valuable insights into the use of these methods in forensic investigations [14].

The paper titled "Forensic Dental Identification using Two-Dimensional Photographs of a Smile and Three-Dimensional Dental Models" presents a method for forensic dental identification using two-dimensional photographs of a smile and three-dimensional dental models. The study proposes a technique for creating three-dimensional dental models from two-dimensional photographs of a smile using photogrammetry software. The three-dimensional dental models can be used to compare the dental characteristics of an unknown individual with a known dental record, which can aid in forensic identification. The paper highlights the advantages of using two-dimensional photographs of a smile in forensic dental identification, as they are readily available and less invasive than traditional methods. Additionally, the use of three-dimensional dental models provides greater accuracy and precision in identifying dental characteristics. The study provides a proof of concept for the proposed method by conducting a case study where the technique was used to identify an individual who had been missing for over a decade. The results of the study showed that the technique was effective in identifying the individual through dental comparison. Overall, the paper demonstrates the potential of using two-dimensional photographs of a smile and three-dimensional dental models in forensic dental identification, providing valuable insights into the use of these methods in forensic investigations.

Miyajima F, et al. [15] The paper titled "Analysis of Smiling Photograph" presents a method for analyzing smiling photographs, particularly in the context of forensic investigations. The study describes the different types of smiles and their characteristics, including the Duchenne smile, which is considered the most genuine and natural smile. The paper highlights the importance of analysing the different components of a smile, including the mouth, teeth, and surrounding facial features, to gather information about the individual. The paper also describes different software tools that can be used to analyse smiling photographs, including facial recognition software and 3D imaging software. These tools can aid in the identification of an individual by comparing their smiling photograph with known photographs in databases or by creating three-dimensional models for further analysis. The study provides several case examples where the analysis of smiling photographs was used in forensic investigations, including identifying missing persons and suspects in criminal cases. Overall, the paper highlights the potential of analysing smiling photographs in forensic investigations and provides valuable insights into the different techniques and software tools that can be used to analyse them [16].

The paper titled "Analysis of the Anterior Dentition Visibility in Photographs and Its Application to Forensic Odontology" presents a method for analysing the visibility of the anterior dentition in photographs and its application to forensic odontology. The study describes the importance of analysing the anterior dentition in forensic investigations, as dental characteristics can be used to positively identify individuals. The paper proposes a method for measuring the visibility of the anterior dentition in photographs using a quantitative index that takes into account the visibility of the incisal edges, buccal corridors, and smile arc. The paper provides examples of how the proposed method can be applied to forensic odontology, including identifying individuals from photographs taken during their lifetime, as well as identifying decomposed or skeletonized remains using post-mortem photographs. The study highlights the advantages of the proposed method, including its objectivity, reproducibility, and accuracy. The paper also describes different software tools that can be used to analyse the visibility of the anterior dentition in photographs, including image processing and analysis software. Overall, the paper provides valuable insights into the importance of analysing the visibility of the anterior dentition in photographs for forensic odontology and presents a quantitative index and software tools that can aid in the analysis of these photographs [17].

The article likely concludes that the analysis of smile photographs, when integrated with meticulous consideration of focal length, can serve as an effective instrument for identification in the fields of forensic anthropology and odontology. By comprehending the correlation between focal length and the portrayal of facial features, forensic specialists could enhance identification methodologies, thereby increasing their reliability in instances of human identification. In summary, this research would offer valuable perspectives on the manner in which focal length affects facial recognition and the precision of smile photograph analysis within forensic environments. It connects the technical facets of photography with the pragmatic requirements of forensic identification [18].

In conclusion, the article presumably emphasizes the significance of utilizing medical findings-including skeletal anomalies, radiographic data, and medical history-together with traditional forensic anthropological methods for achieving a more dependable and precise determination of human identity. By integrating medical expertise into forensic scenarios, professionals can address the difficulties presented by damaged or decomposed remains and enhance the identification procedure. The study may underscore the necessity for interdisciplinary cooperation among anthropologists, pathologists, odontologists, and radiologists in resolving forensic cases. This research would contribute significantly to the progressive enhancement of techniques employed in forensic anthropology, assisting professionals in refining methods for the identification of human remains, especially in instances where the remains are incomplete or extensively damaged [19].

In conclusion, "Forensic Odontology: A Handbook for Human Identification" offers a comprehensive examination of the significant role that dental evidence serves in forensic investigations. It underscores the techniques employed to evaluate dental records, bite marks, and other dental characteristics in the identification of individuals. The research and methodologies covered are not only essential for recognizing victims of crimes or disasters but also for reinforcing the legal proceedings through expert testimony presented in court. This research holds significant relevance for practitioners in forensic science, law enforcement, and legal professions, as it highlights the critical nature of precise and dependable human identification techniques in both standard and intricate cases. By concentrating on the significance of dental evidence, it aids in establishing forensic odontology as a crucial resource within the extensive forensic arsenal [20].

## Objectives

- To Check the efficiency of smile photograph analysis for identification.
- To establish parameter for smile photograph identification analysis.
- To validate the method for identification.
- To ascertain parameters changing with ages.

## Methodology

- Acquiring a smile photo of the person: A high-quality smile photo is needed for the analysis. This photo should be clear and well-lit.
- Analysing the smile: The smile is analysed to determine the position of key landmarks on the face, such as the corners of the mouth, the center of the upper lip, and the position of the teeth.
- Generating a 3D model: Using the information obtained from the smile analysis, a 3D model of the person's face is generated.
- Refining the model: The 3D model is refined using additional information, such as photographs of the person from other angles or information about their age and gender.
- Creating a reconstruction: Using the 3D model as a guide, a reconstruction of the person's face is created.

Facial reconstruction using smile photo analysis is still a relatively new technique, and there are limitations to its accuracy. The technique may not work well for people with unique facial features or for people with missing teeth. However, with further research and development, this technique has the potential to become a valuable tool for forensic investigations, helping to identify unknown individuals based on a single photograph of their smile.

Overall, smart photograph analysis has the potential to save time, improve accuracy, and enhance our understanding of visual information. However, it is important to consider the ethical implications of using this technology, particularly in terms of privacy and bias.

## Dental Characteristics

Dental characteristics refer to the unique features and properties of the teeth. Some of the dental characteristics include:

1. **Shape:** Teeth have different shapes depending on their position in the mouth. For instance, incisors have a flat, chisel-like shape for cutting, while molars have a more complex shape for grinding food.
2. **Size:** Teeth vary in size depending on their location in the mouth. Incisors are typically smaller than molars.
3. **HD quality:** Smiling photographs of 25 individuals would be taken for analysis. One of the photographs would be of age group: 11-14 years, 18-22 years, 30-34 years
4. **Colour:** Teeth can vary in colour, ranging from white to yellow or brown. Tooth discoloration can be caused by factors such as genetics, aging, or lifestyle choices such as smoking or consuming certain foods and drinks.
5. **Position:** Teeth are positioned differently in the mouth depending on their function. For instance, front teeth (incisors) are positioned to allow for biting and cutting, while back teeth (molars) are positioned for grinding.
6. **Number:** Humans have two sets of teeth in their lifetime - baby teeth and permanent teeth. The number of teeth in each set can vary, but adults typically have 32 permanent teeth.
7. **Enamel**: The outer layer of the tooth is called enamel. It is the hardest substance in the human body and protects the tooth from decay.
8. **Dentin:** Beneath the enamel lies the dentin, which is softer and more porous than enamel. It is made up of microscopic tubules that communicate with the nerve inside the tooth.
9. **Pulp:** The pulp is the innermost layer of the tooth, containing nerves and blood vessels. It is essential for tooth vitality and can become damaged if a tooth is infected or injured.
10. **Root:** The root of the tooth anchors it into the jawbone. It is covered by a layer of cementum and contains the tooth's nerves and blood vessels.

## Facial Features

Facial features can be very useful in forensic anthropology for identifying individuals or reconstructing their appearance based on skeletal remains. Forensic anthropologists use a variety of techniques to analyse facial features, including:
- Craniofacial Superimposition: This technique involves

overlaying a photograph of a person's face onto a photograph of their skull. By matching the contours of the face to the skull, forensic anthropologists can determine if the skull belongs to the same individual.

- Facial Reconstruction: This involves using the skull and other anatomical information to create a three-dimensional model of the face. Forensic anthropologists use tissue depth markers and other measurements to estimate the shape and size of the facial features.
- Photogrammetry: This involves using a series of photographs taken from different angles to create a 3D model of the face. This technique can be used to written internal consent of the participates would be taken these photos would be distaller, reconstruct the appearance of a person from their skull or to identify an individual from CCTV footage.
- Dental Analysis: Teeth can also be used to identify individuals, as they are unique to each person. Forensic anthropologists can use dental records or compare the teeth of a skull to the dental records of missing persons.

Overall, facial features can be an important tool for forensic anthropologists in identifying individuals or reconstructing their appearance. Once all of this information has been gathered, a forensic artist can use it to create a reconstruction of the individual's face. The reconstruction process involves creating a clay or digital model of the individual's skull and then adding tissue depth markers to the model to determine the thickness of the soft tissues. The artist can then add muscle, skin, and other features to create a facial approximation of the individual. Anti-mortem analysis is an important tool in forensic investigations, as it can help identify unknown individuals and provide closure for families and loved ones.

## Conclusion

In summary, examining smile photographs presents a valuable resource in forensic anthropology and odontology for identifying individuals. By analysing the distinctive features of dental anatomy, positioning, and facial expressions, images of smiles can yield important additional insights alongside conventional identification approaches.

Although additional research and standardization are necessary to boost precision and applicability, combining smile photograph analysis with other forensic methods has the potential to enhance identification procedures in criminal inquiries and legal matters.

## References

1. Goodman NR, Himmelberger LK (2002) Identifying Skeletal Remains Found in A Sewer. J Am Dent Assoc 133(11): 1508-1513.

2. Kirk NJ, Wood RE, Goldstein M (2002) Skeletal Identification Using the Frontal Sinus Region: A Retrospective Study Of 39 Cases. J Forensic Sci 47(2): 318-323.

3. Lorkiewicz-Muszynska D, Przystanska A, Glapinski M, Kociemba W, Zaba C (2013) Difficulties in Personal Identification Caused by Unreliable Dental Records. J Forensic Leg Med 20(8): 1135-1138.

4. Marks MK, Bennett JL, Wilson OL (1997) Digital Video Image Capture in Establishing Positive Identification. J Forensic Sci 42(3): 492-495.

5. McKenna JJ (1986) A Qualitative and Quantitative Analysis of The Anterior Dentition Visible in Photographs and Its Application in Forensic Odontology. Hong Kong: University of Hong Kong.

6. Nagai K, Sakoda S, Maeda H (1997) Dental Identification of Decomposed Victims in a Case of Multiple Homicides by Infection of Succinylcholine. J Forensic Odontostomatol 2(15): 37-44.

7. Okoye MI, Wecht CH (2007) Forensic Investigations and Management of Mass Disasters. 1st (Edn.), Lawyers & Judges Publishing Co. Inc., USA.

8. Senn DR, Weems RA (2013) Manual of Forensic Odontology. 5th (Edn.), CRC Press, USA.

9. Silva RF, Pereira SD, Prado FB, Daruge E, Daruge E (2008) Forensic Odontology Identification Using Smile Photograph Analysis - Case Reports. J Forensic Odontostomatol 26(1): 12-17.

10. Sheikh S, Pallagatti S, Singla I, Gupta R (2011) Postmortem Dental Identification in the Absence of Anti-Mortem Records - A Review. J Forensic Res 2: 132.

11. Silva RF (2004) Confiability of Forensic Dental Exam in Human Identification. ROBRAC 13(35): 46-50.

12. Silva RF (2006) Dental Radiographs: Source of Information for Human Identification. Odontologia Clín. Cientif 5(3): 239-242.

13. Silva RF, Pereira SDR, Daruge E, Barcelos RSS, Godinho NMO (2007) Genetics and Molecular Biology: A Literature Review of Forensic Dentistry Applications. Braz J Oral Sci 6(20): 1254-1259.

14. Silva RF (2005) The Importance of Dental Documentation in Human Identification: Report of A Case. Acta Odontol Venez 43(2): 67-74.

15. Silva RF, Franco A, Mendes SD, Picoli FF, Marinho ADE

(2014) Human Identification Through the Patella – Report of Two Cases. Forensic Sci Int 238: e11- e14.

16. Miyajima F, Daruge E, Daruge E (2001) The Importance of Dental Science in Human Identification: A Casework Report. Arq Odontol 37(2): 33-42.

17. Mazur M, Gorka K, Aguilera IA (2022) Smile Photograph Analysis and Its Connection with Focal Length as One of Identification Methods in Forensic Anthropology and Odontology. Forensic Science International 335: 111285.

18. Terada AS, Leite NL, Silveira TC, Secchieri JM, Guimaraes

MA, et al. (2011) Human Identification in Forensic Dentistry from A Photographic of Smile: A Case Report. Rev Odontol UNESP 40(4):199-202.

19. (2023) Forensic Odontology: A Handbook for Human Identification. In: Nanda A, Singh J (Eds.), Bentham Science Publishers.

20. Lemos YV, Furtado AN, Lima AZ, Dionisio AS, Araujo RM, et al. (2024) Human Identification by Medical Findings in a Forensic Anthropology Context. Forensic Sciences Research 9(3): owae041.