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A NEW DIMENSION IN FORENSICS

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3D printing or additive manufacturing is a method for creating a three-dimensional object layer-by-layer using a computer-created design.

The application of 3D printing in the field of medicine and dentistry has skyrocketed in recent years because of its ability to produce highly realistic physical 3D Structures of the computer- aided design model.

How does a 3D printer work?

MODELING: Digital imaging and communications in medicine images are used to create 3D printed models using different modeling softwares. 3D printers accept standard tessellation language file format that defines surfaces like a collection of triangles that fits together like a puzzle. We can design our model by using basic shapes and structures. The additive manufacturing file format is a newer format approved by ASTM(American Society for Testing and Materials) International to incorporate surface texture color and material properties.

SLICING: The 3D printing software scans and slices the model so that the printer understands the shape and how to print it.

The filament is the material that the models are printed from such as plastics, metals and ceramic.

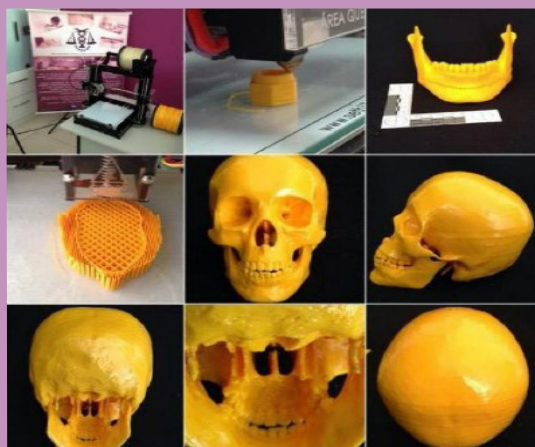
The printer has a printing plate that moves up and down. The print head that moves in any direction has a heating element when the filament is fed, it melts and draws the first slice outline and then fills it in. Layers are deposited to generate the 3D model.

The quality of 3D printers depends on the technology. Stereolithography was considered to be the most accurate as it provides better resolution by utilizing a scanning laser to fuse fine powder material generating a layer-by-layer structure, and the light-sensitive polymer is cured and hardened in a UV oven.

APPLICATIONS:

1. DOCUMENTATION

Human remains offer conclusive proof in the area of forensics, the documentation is mostly done in the form of photographs and electronic copies owing to legal and ethical problems. 3D printing of human remains can convey important details to the court and jury.



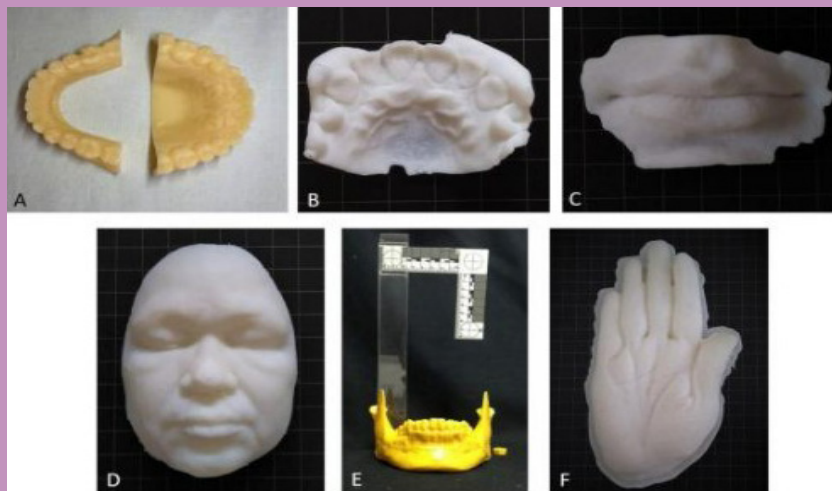
3D Printed models of mandible and skull for documentation

Credits:<https://ars.els-cdn.com/content/image/1-s2.0-S2666964121000011-gr1.jpg>

It can be transported for consultation without transporting the remains. During a virtual autopsy, files are acquired in DICOM(Digital Imaging and Communications in Medicine) files and 3D models in their hands, and forensic experts can revisit the case without exhumation. Printed models may soon be a part of ante-mortem for comparative human identification.

2. HUMAN IDENTIFICATION

An accurate model of the maxilla and mandible dentition may be useful in age estimation and sex determination. A 3D model obtained from postmortem computed tomography helps to minimize difficulties in traditional autopsies such as examination due to rigor mortis or lack of proper visualization. 3D models of skull, sinuses, face, fingerprints, lip prints ,and palatal aid in identification and can serve as evidence in the future.

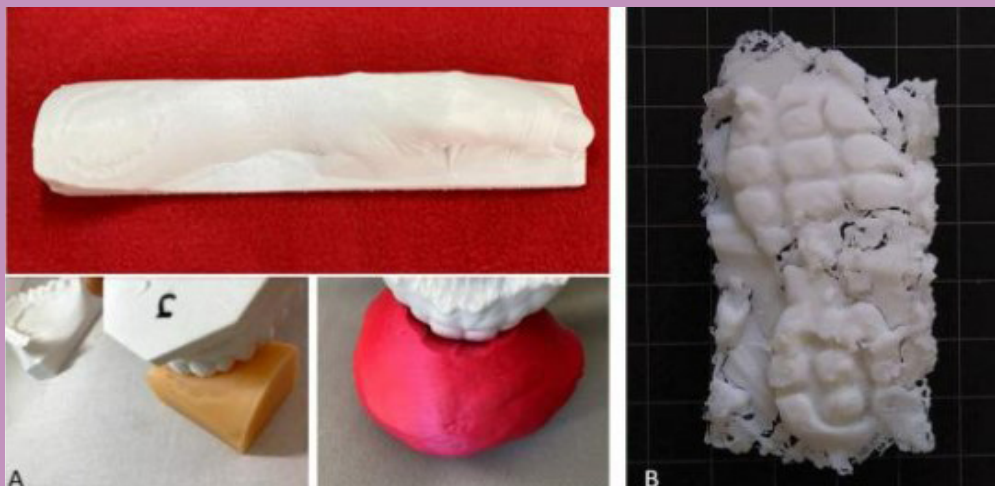


A) 3D printed upper and lower dentition for morphometric analysis, (B)3D printed rugae (C) 3D printed lips for coloscopy (D)3D printed face for future referral (E) 3D printed mandible (F) 3D printed Palm.

Credits:<https://ars.els-cdn.com/content/image/1-s2.0-S2666964121000011-gr2.jpg>

3. BITEMARKS AND PATTERN ANALYSIS

Bite marks analysis is evaluated on a comparative basis in which morphological features of dentition and bite marks are matched. 3D printing enables storage of alleged suspect dentition which can be used for future analysis by retrieving it. Bite marks might be scanned from the skin, foodstuff, and objects enabling 3D or printed comparisons. Impression evidence recovery like tire, footwear impression, tool mark analysis 3D model can be scaled up and printed to aid in the investigation and can be used for courtroom presentation.



(A) 3D printed bite-mark on hand(top) analysis of bite-mark(bottom)

(B) 3D printed footwear pattern impression.

Credits:<https://ars.els-cdn.com/content/image/1-s2.0-S2666964121000011-gr4.jpg>

4. FACIAL RECONSTRUCTION

A method of recreating an individual's face from skeletal remains by utilizing tissue markers. Printing skulls from computed tomography enables reconstruction of the face without damage to the original skull of anthropological or archaeological value.

5. BALLISTIC RECONSTRUCTION

Fired bullets can be scanned and 3D printed. They can be compared to check for deformation. Bullet trajectories can be generated using digital imaging techniques, which can be printed for presenting as evidence and demonstrating a case scenario.



3D printed bullets unfired bullets and fired and deformed bullets(left right)

credits:<https://ars.els-cdn.com/content/image/1-s2.0-S2666964121000011-gr5.jpg>

6. DISASTER VICTIM IDENTIFICATION

CT(Computed Tomography) scan of severely charred remains of maxillary and mandibular teeth can be used for identification in disaster victim identification. 3D scanning of the remains will facilitate the handling and analysis of burnt remains and court presentation.

7. CRIME AND ACCIDENT SCENE RECONSTRUCTION

3D printing of various vehicle models in case of accident reconstruction can aid in demonstrating the relationship between the collided vehicles.

ADVANTAGES:

1. Visual representation of anatomy in court.
2. 3D printed evidence can be revisited and re-evaluated in case of decomposition, burial ,or destruction of original evidence.
3. Better visualization

DISADVANTAGES:

1. The accuracy of 3D prints leads to issues of admissibility in court.
2. Easily accessible as it can be shared, downloaded, modified ,and printed.
3. Typical characteristics cannot be replicated.

CONCLUSION:

3D Printing allows for better visualization, interpretation ,and understanding. It is a humanitarian approach as the evidence is reconstructed without touching or damaging the evidence.3D printing technology in India is still in the initial stages but newer methods can transform its application in the field of forensics.

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