Makarevich-Konstantinova A.I., Khalaf M.S.

APPLICATION OF PHOTOGRAMMETRY IN MEDICINE

Tutor: PhD, associate professor Belaya O.N.
Department of Medical and Biological Physics
Belarusian State Medical University, Minsk

Relevance. In modern medicine, precisely determining the shape, size, and spatial position of anatomical structures holds immense scientific and practical importance, as visual inspection yields only approximate results, necessitating reliable non-contact measurement methods. Photogrammetry, as a 3D scanning technology based on photo series, reconstructs object geometry with millimeter accuracy without radiation exposure, actively applied in diagnosis, monitoring, and treatment planning. From a physics standpoint, the method relies on triangulation and stereovision principles, where parallax between images calculates depth via the formula $d = b*f/\Delta p$, achieving <0.5 mm error with proper calibration. This positions it as a promising tool for orthopedics, surgery, rehabilitation, and even forensic medicine, minimizing patient risks, especially in children.

Aim: to investigate photogrammetry's physical foundations, analyze its applications across medical fields, evaluate advantages, limitations, and implementation prospects to enhance diagnostic and monitoring accuracy without invasive procedures.

Materials and methods. The method's physical basis involves registering reflected visible electromagnetic radiation using central projection laws, geometric optics, and triangulation akin to binocular vision. Cameras capture object projections, with algorithms solving equation systems for 3D coordinates. This study systematically reviewed scientific literature (>50 publications from 2015–2025), clinical trials, and technical workflow descriptions of photogrammetry in medicine, covering orthopedics (scoliosis), surgery (orthognathic), rehabilitation (gait analysis), stomatology, dermatology, and telemedicine. Software examples (Agisoft Metashape, RealityCapture) and hardware needs (>20 MP cameras) were examined.

Results and their discussion. Photogrammetry excels in orthopedics for posture and spine deformity analysis in scoliosis: it generates back topographic maps, measures Cobb angles and torso asymmetry without X-rays, reducing pediatric radiation load (reproducibility <1° per European Spine Journal). Surgery benefits from organ 3D models for preoperative planning, e.g., jaw corrections or chest breathing simulations; stomatology uses volumetric dental casts for CAD/CAM prosthetics. Rehabilitation employs markerless joint angle/trajectory tracking with AI-automated gait analysis in neurology; pediatrics standardizes growth assessments for early dysplasia detection. Additional uses include wound/skin lesion monitoring, tooth wear quantification, facial growth tracking (pre/post-op), and forensic injury documentation with high-detail volume/shape capture. Telemedicine enables remote 3D model sharing for objective consults. Key strengths: non-contact, rapid, safe, high precision. Limitations: high-res imaging demands, calibration sensitivity, computational intensity–though AI mitigates these, commercialization lags.

Conclusions. Photogrammetry emerges as a transformative non-invasive tool, integrating precise 3D reconstruction with everyday photos to revolutionize orthopedics, surgery, rehab, dentistry, dermatology, forensics, and telehealth. Despite processing challenges, its radiation-free accuracy and versatility promise widespread adoption, especially with AI advancements, for superior spatial medical insights.