Cell phone video technology unveils new method for analyzing walking and gait

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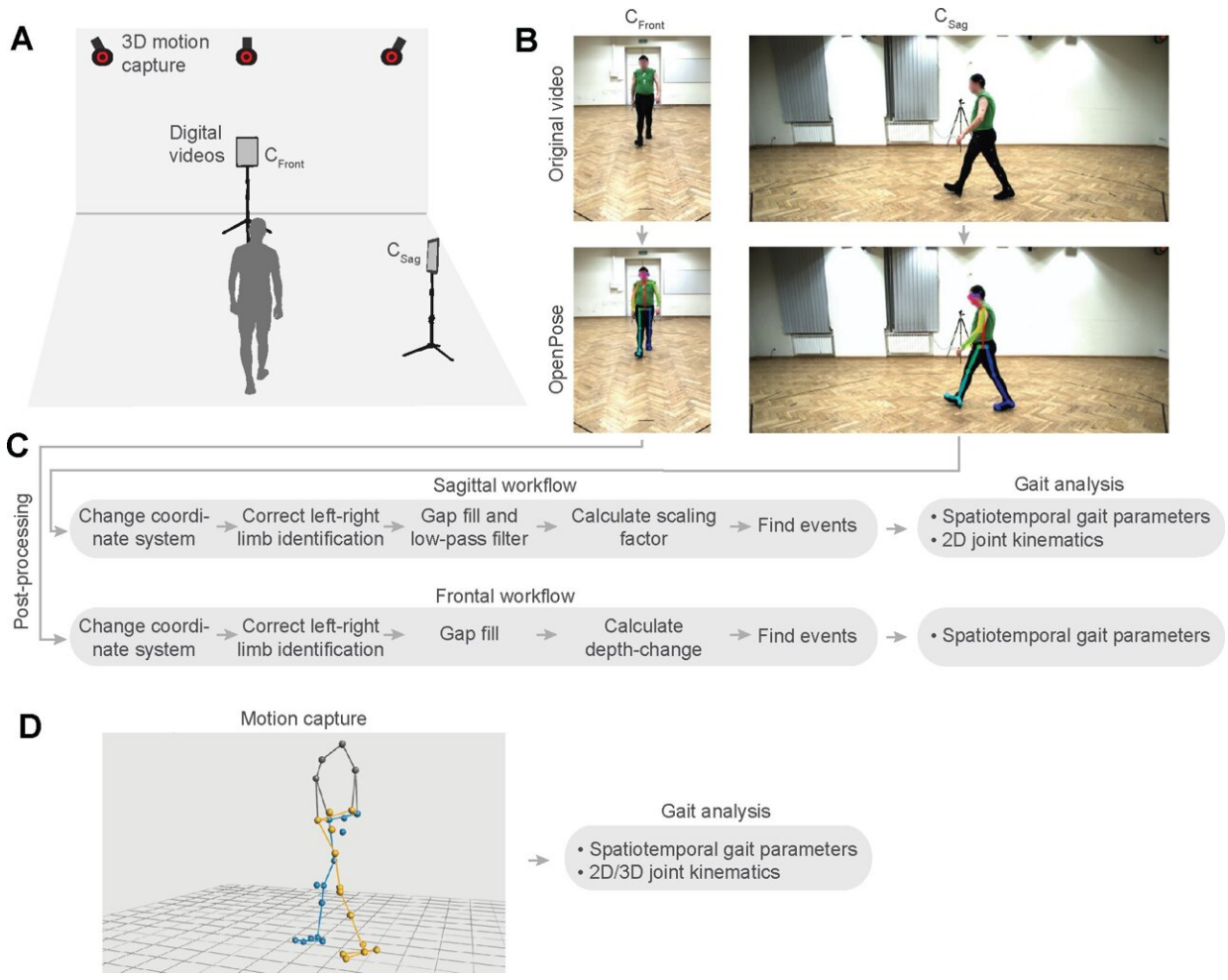

We recorded three-dimensional (3D) motion capture and digital videos of gait trials performed by persons post-stroke and persons with Parkinson's disease (A). We analyzed digital videos of the frontal (CFront) and sagittal plane (CSag) with OpenPose to track anatomical keypoints (B). We developed workflows to perform a gait analysis independently for videos of the frontal and sagittal plane

(C). See the Methods section for detailed information about the frontal and sagittal plane post-processing workflows. Note that the 'Calculate depth-change time-series' step in the frontal workflow contains multiple sub-steps, including tracking the pixel size of the torso and low-pass filtering (see S4 Fig for justification of tracking method and smoothing). We compared spatiotemporal gait parameters and joint kinematics from our workflows to parameters obtained with 3D motion capture (D).

Researchers at Kennedy Krieger Institute and Johns Hopkins Medicine have developed a new, accessible approach to analyze a patient's walking ability and stances more effectively. Following numerous tests, they determined that a simple video recorded on a personal pocket device, such as a smartphone or tablet, can be used to measure gait at a clinical, high-quality level.

Experts say current state-of-the-art approaches to gait analysis are often expensive and inaccessible due to time constraints and extensive efforts required for assessments. However, there is a significant need for this analysis in patients experiencing conditions such as traumatic brain injury, physical injury, or disorders. Through freely available software they created, walking abilities can now be assessed more conveniently, enhancing the comprehensiveness of rehabilitation.

Dr. Ryan Roemmich, a research scientist at the Kennedy Krieger Institute, assistant professor of physical medicine and rehabilitation at the Johns Hopkins University School of Medicine, and co-principal investigator on this project, emphasizes the promising aspect of being able to perform a high-quality gait analysis using nothing more than the smartphone in your pocket.

"We really need better ways of measuring a person's gait that could be easily accessible to all clinicians and researchers," Dr. Roemmich said.

"Patients that have gait problems resulting from diverse conditions such as Parkinson's Disease, cerebral palsy, lower extremity injury or amputation, recovery from a stroke, and more, could benefit from this."

Clinicians use cutting-edge software in the assessment to record a cellphone video that captures the patient's walking pattern from any one of multiple perspectives. The videos could be recorded as the patient walks toward the camera, away from the camera, or from a profile angle, depending on the condition being treated. Dr. Roemmich explains that with the ability to record these videos anywhere, they are not limited to testing in a physician's office.

"It's not uncommon for a clinician to only have access to a long, narrow hallway or hospital corridor," Dr. Roemmich said. "This can be limiting, making a side view recording of a patient impossible. There are now possibilities to record gait patterns on a sidewalk or comfortably inside a hallway within the patient's home."

The researchers use algorithms and their software to analyze the recorded data, marking the movement of patients' knees, ankles and the length of their steps. Their approach is also based on tracking the size of the person as they appear in the video image. Patients were observed walking on the ground and on the treadmill.

Dr. Jan Stenum, a research associate at Johns Hopkins University and an additional co-investigator in this research, explains that clinicians will first need to be trained in how to use this technology to produce the best results effectively. But eventually, they want patients to be capable of shooting the videos at home themselves.

"For the best results, all of this is easier to perform in a standardized space by clinicians or researchers," Dr. Stenum said. "However, we aim to make it fully possible for patients and families to record these videos

themselves on their own devices and then send them to us for analysis."

Dr. Roemmich and Dr. Stenum hope that this development will encourage more doctors across the U.S. to investigate similar alternatives when it comes to the medical analysis of a person's gait.

"This could propel future research into how these technologies can be used in other forms of rehabilitation," said Dr. Roemmich. "I look forward to fine-tuning our approach and implementing this method for patients who need it most."

More information: Jan Stenum et al, Clinical gait analysis using video-based pose estimation: Multiple perspectives, clinical populations, and measuring change, *PLOS Digital Health* (2024). DOI: 10.1371/journal.pdig.0000467

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