ABSTRACT

Abnormal foot posture in children can lead to long-term biomechanical disorders, making early detection crucial. However, conventional clinical methods that rely on manual palpation tend to be subjective, time-consuming, and difficult to apply on a large scale. Previous research has shown that 3D photogrammetry can enhance measurement objectivity, but existing prototypes still have limitations, such as large dimensions (>80 cm) and long data acquisition times (>4 minutes) This study aims to develop a more compact, rapid, and accurate 3D photogrammetry mechatronics system to classify the foot posture of children aged 5–13 years based on the Foot Posture Index-6 (FPI-6) method.

The system consists of a Raspberry Pi camera rig that rotates 360° on a 43 cm diameter PETG *lazy Susan* platform, controlled by a DC *gearbox* motor with an *encoder* and a BTS7960 *driver* via an Arduino R4 WiFi microcontroller. The 3D reconstruction process is performed using Agisoft Metashape and Blender software for automatic feature extraction based on the six FPI-6 criteria. The test results show that this system successfully surpassed its design targets, with a total mass of only 11.2 kg (far below the 50 kg target), dimensions 46.15% more compact than the previous prototype, and an average data acquisition duration of only 1 minute and 33 seconds, under the 4-minute limit. Optimal 3D model quality was achieved at a camera angle of 58° and with a transparent background. 15 child subjects showed a classification accuracy of 53% compared to the *Rear Foot Angle* (RFA), which successfully exceeded the set target of 50%.

Although the minimum accuracy target was met, further improvements in classification accuracy remain a primary focus that can be achieved through refining FPI-6 quantization parameters, recalibrating thresholds, and potentially integrating *machine learning* methods in feature extraction. This research contributes to the development of a rapid and compact clinical 3D data acquisition platform. This platform serves as a promising initial foundation for developing affordable technology to support children's foot health screenings in the future.

Keywords: Mechatronics, 3D Photogrammetry, Foot Posture Index-6 (FPI-6), Foot Posture Classification.