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Perfect Path: An AI-Powered Pose Detection System for Personalized Golf Swing Visualization and Inclusive Sports Engagement

Golf is a sport associated with technical precision and long-term participation. However, access, instruction costs, and social barriers can limit entry for many new players. *Perfect Path* explores how computer vision and pose estimation can support individualized swing analysis while lowering barriers through accessible, mobile-based technology. We frame the problem as both a biomechanics challenge, helping users understand body positioning and rotational mechanics, and a design challenge, creating tools that make golf instruction more approachable and data-informed.

Our system uses user-provided videos as its primary input. Through a structured video-to-image workflow, users upload their footage, select a specific key frame, and apply pose detection to extract body lines and joint positions. Using Python and OpenCV, the pipeline estimates joint locations, evaluates angles and rotation, and exports a processed skeletal overlay for visualization and comparison. This transforms raw golf footage into interpretable visual feedback focused on alignment, posture, and swing path. The prototype demonstrates a complete end-to-end workflow. First is video upload, second comes frame selection, third is automated pose detection, and lastly, an exportable visualization is provided to the user. Importantly, the system does not employ predictive modeling to forecast performance outcomes such as hot distance or scoring improvement. Instead, it prioritizes transparent, interpretable visual analytics that allow users to directly observe their mechanics. By avoiding predictions, the tool emphasizes general skill development through self-assessment rather than guiding users to improve on a specific course without raising their overall skill level.

From an inclusion perspective, the system is designed to reduce intimidation often experienced by beginners in traditional golf settings. Instruction can be costly, socially hierarchical, and reliant on in-person correction. By enabling private, self-paced analysis on a personal device, users can identify and correct mechanical errors without the pressure of public critique. This approach may help create a more welcoming entry point for individuals who feel underrepresented in golf spaces. Future development for this project includes a real-time mobile application capable of live swing capture, immediate pose-based feedback, and side-by-side comparison with a built-in reference skeleton. These enhancements would extend usability while maintaining a clear, interpretable analytics framework.