



UNIVERSITY OF WOLVERHAMPTON

PROJECT AND PROFESSIONALISM

(6CS007)

LITERATURE REVIEW REPORT

FITNESS COMPANION APPLICATION

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Abstract

The review encompasses studies by (Abeltino, et al., 2024), (Hitesh, et al., 2024), (Salik, et al., 2022), (Sebastian, et al., 2023), (Stockwell, et al., 2021) and (Zhao, et al., 2020) which explores advancements in fitness monitoring, physical activity management, and health improvement through the integration of emerging technologies such as computer vision, AI, gamification, and real-time feedback systems. It highlights key findings from journal articles and applications, focusing on pose estimation accuracy, the impact of COVID-19 on physical activity, personalized fitness recommender systems, diet monitoring tools, and non-contact exercise monitoring methods. Studies reveal the limitations of current pose estimation tools like MediaPipe in suboptimal conditions, emphasizing the need for advanced validation frameworks. Real-time feedback systems, such as FitSight, have proven effective in improving exercise form and reducing injury risks. The COVID-19 pandemic further showcased the importance of digital fitness solutions in overcoming barriers to physical activity, although most apps lack critical features like pose correction and gamification. Gamified fitness systems and AI-driven dietary tools demonstrated significant improvements in motivation and precision, highlighting their potential for personalized health management. Non-contact computer vision solutions offer promising alternatives to traditional sensor-based monitoring, though challenges like motion artifacts persist. By integrating advanced technologies and addressing existing gaps, fitness applications can become more accessible, engaging, and effective. This review underscores the transformative potential of fitness technologies in enhancing physical and mental well-being, providing a foundation for future innovation.

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1. Literature Review

1.1. Journal Articles

1. Accuracy Evaluation of 3D Pose Estimation with MediaPipe Pose for Physical Exercises

(Sebastian, et al., 2023) examines the accuracy of MediaPipe Pose, a widely used pose estimation library, in health-critical applications like physical therapy, where precision is essential. It highlights a research gap in validating MediaPipe Pose for key medical metrics, such as joint angles and body dimensions. Using motion capture (MoCap) as ground truth, the study evaluates MediaPipe's performance under controlled conditions, focusing on factors like camera positioning and viewing angles. Results reveal that while MediaPipe offers computational efficiency, its accuracy diminishes significantly in suboptimal conditions, such as occlusions and varying perspectives. The study emphasizes the need for robust validation frameworks to ensure safety and reliability in medical use cases. Additionally, it identifies challenges in applying pose estimation tools in health scenarios, providing recommendations to enhance MediaPipe's utility. This work contributes to improving pose estimation accuracy for applications demanding high precision and trustworthiness.

2. Changes in Physical Activity and Sedentary Behaviors from Before to During the COVID-19 Pandemic Lockdown: A Systematic Review

(Stockwell, et al., 2021) conducts a systematic review of 66 studies involving 86,981 participants revealed significant shifts in physical activity (PA) and sedentary behavior (SB) during COVID-19 lockdowns. PA levels dropped while SB increased across diverse populations, including children, adults, and individuals with medical conditions. Restrictions on movement and gym closures disrupted routines, leading to declines in PA, which negatively affected physical and mental health. Those previously more active

experienced greater PA reductions, worsening stress and fatigue. Conversely, individuals with eating disorders saw increased PA due to unhealthy exercise habits.

The review highlights the effectiveness of digital exercise solutions, such as online fitness classes, in mitigating these trends. It also identifies research gaps, including inconsistent measurement methods and insufficient data on PA types and intensity.

3. Effects of a Personalized Fitness Recommender System Using Gamification and Continuous Player Modeling: System Design and Long-Term Validation Study

(Zhao, et al., 2020) introduces a gamified fitness assistant system that integrates wearable tracking and continuous player modeling to deliver personalized exercise recommendations. By combining gamification—adding game-like features to activities—with tailored suggestions, the system aims to boost physical activity engagement. Recognizing that preferences and motivations vary, it adapts to individual users using wearable data to update their profiles over time.

In a 60-day study with 40 participants, three groups were compared: one received a fully personalized, gamified experience, another received only personalized recommendations, and the third received generic suggestions. Results showed that personalization and gamification significantly improved motivation and satisfaction. Participants using the personalized, gamified system reported higher engagement, and feedback highlighted potential enhancements, including customized storylines, multiplayer modes, goal-setting, and location-based features.

4. Digital Applications for Diet Monitoring, Planning, and Precision Nutrition for Citizens and Professionals: A State of the Art

(Abeltino, et al., 2024) provides an overview of digital tools designed to assist individuals and professionals in managing personalized dietary practices. Poor diet is linked to

chronic illnesses like obesity and diabetes, and traditional tracking methods are often time-consuming. Digital applications simplify these processes by offering tailored nutrition advice.

The tools are categorized by target users:

- **Citizens:** Apps for self-monitoring diets, managing weight, and controlling diabetes, featuring food logging and calorie counting but facing challenges like data accuracy and engagement.
- **Nutritionists:** Tools to create and adjust client-specific diet plans, improving efficiency in counseling.
- **Physicians/Researchers:** Platforms using genetic data to deliver precision nutrition recommendations.

AI and machine learning enhance personalization, while blockchain technology is being explored for secure data handling. However, challenges such as accuracy, accessibility, and affordability remain. The article stresses the need for continued innovation to maximize the potential of digital dietary tools.

5. FitSight: Tracking and Feedback Engine for Personalized Fitness Training

(Hitesh, et al., 2024) proposed FitSight, which is an innovative fitness system leveraging the YOLOv7 model and a standard webcam to provide real-time posture feedback during exercises. By analyzing movements through computer vision, FitSight offers immediate, personalized textual guidance, helping users maintain proper form, reduce injury risk, and enhance workout effectiveness without requiring a professional trainer. Additionally, it counts repetitions and encourages real-time self-correction for safer exercise practices.

A controlled study simulating a gym environment evaluated FitSight's impact on exercise technique. Participants using its real-time feedback demonstrated significant

improvements compared to those relying on traditional training methods without immediate guidance. This highlights FitSight's potential to improve workout safety and quality.

FitSight showcases how AI-powered systems can revolutionize fitness training by offering accessible, cost-effective solutions. Its development represents a step forward in human-computer interaction and fitness technology, democratizing professional-level coaching for diverse users.

6. A review on Computer Vision Technology for Physical Exercise Monitoring

The article (Salik, et al., 2022) highlights advancements in computer vision for non-contact exercise monitoring, offering an alternative to traditional sensor-based methods. Techniques like video-based photoplethysmography (PPG) measure heart rate and respiratory rate by analyzing skin color changes, ensuring accuracy and user comfort. Deep learning models enhance these methods, using video data to deliver precise vital sign measurements and exercise metrics. Applications include fitness tracking, real-time feedback, and healthcare uses like rehabilitation and remote monitoring. Despite challenges like motion artifacts and environmental factors, ongoing research aims to improve reliability, making computer vision a promising tool for accessible and effective exercise monitoring.

1.2. Similar applications

1. MyFitnessPal

MyFitnessPal (FitnessApp, 2024) is a popular fitness app that focuses on tracking calories, meals, and weight management. It has a large database of over 11 million food items, making it easy for users to log their meals and monitor calorie intake. The app also lets users track physical activities and connect with fitness devices for a complete health

overview. Its simple design and active community forums make it a favorite for people working on their dietary goals. However, MyFitnessPal lacks advanced features like real-time pose tracking, personalized workout plans, or gamified tools to keep users motivated.

2. Nike Training Club

Nike Training Club (nikw, 2024) is a fitness app that offers high-quality workout routines created by professional trainers. It includes a wide range of guided programs for strength, endurance, mobility, and yoga, making it suitable for users at all fitness levels, from beginners to advanced athletes. The app provides clear audio and video instructions to ensure workouts are easy to follow. It also offers tailored programs for specific goals like weight loss or muscle building. However, Nike Training Club focuses mainly on workout guidance and lacks features like integrated nutrition planning or real-time posture feedback. Its customization options are also more limited compared to other fitness apps that offer personalized experiences.

3. Strong Workout Tracker Gym Log

Strong (Anon., 2024) is a fitness app designed for those focused on strength training, such as weightlifting and resistance exercises. It enables users to track their sets, reps, and weights, helping them monitor their progress over time. The app's simple design makes it quick and easy to log workouts, and it includes helpful tools like rest timers and detailed workout statistics.

While Strong is an effective tool for tracking strength training, it does not offer guidance on proper exercise form, real-time pose feedback, or features like nutrition planning or gamified engagement. Its primary purpose is to serve as a digital logbook for tracking strength workouts.

4. FitOn

FitOn (On, 2024) is a fitness app that offers a wide range of workout videos and training programs for users ranging most of the fitness levels. It offers guided sessions in various categories, including cardio, strength, yoga, and Pilates, led by renowned trainers. The app's social feature allows users to compete with friends, enhancing motivation through friendly competition. FitOn also provides workout personalization based on user preferences and fitness goals. While it excels in offering variety and engagement, it lacks real-time pose feedback and the advanced features of personalized nutrition plans. Moreover, it doesn't incorporate tools like pose estimation or in-depth exercise tracking. However, its intuitive design, integration with wearables, and community-driven model make it a valuable fitness companion for many users.

5. JEFIT Workout Planner

JEFIT (jefit, 2024) is a comprehensive fitness app tailored for individuals focused on gym-based strength training. It includes an extensive exercise library, with detailed instructions and visuals for each movement, making it ideal for both beginners and experienced athletes. Users can create and customize workout plans, track progress, and analyze detailed performance reports. JEFIT also supports social engagement through its fitness community, fostering accountability and competition. Despite its robust tracking capabilities, the app doesn't offer real-time feedback on form or pose, nor does it include integrated nutrition planning or features like gamified engagement. Nonetheless, its ability to provide data-driven insights and structured workout management sets it apart as a top choice for strength training enthusiasts.

2. Analysis and findings

The reviewed literature highlights the increasing role of technology in fitness monitoring, physical activity management, and health improvement. Through various studies,

significant advancements in computer vision, gamification, personalized recommended systems, and real-time feedback mechanisms have been demonstrated to improve user engagement and fitness outcomes. Key findings from the studies are analyzed below

1. Accuracy in Pose Estimation for Exercises

Statistical findings from (Sebastian, et al., 2023) highlight MediaPipe Pose's reduced accuracy under suboptimal conditions. Descriptive analysis suggests that improving pose estimation tools is vital for fitness and health-critical scenarios like rehabilitation. While apps such as Nike Training Club and FitOn offer guided workouts, they lack real-time pose estimation or posture correction, underscoring a gap for more advanced solutions.

2. Impact of COVID-19 on Physical Activity

(Stockwell, et al., 2021) presented statistical evidence of declining physical activity during lockdowns, with sedentary behavior increasing across populations. Descriptive insights emphasize the effectiveness of digital fitness solutions like MyFitnessPal, which mitigated disruptions by promoting dietary tracking and exercise routines. However, apps like Strong and JEFIT focus mainly on workout logging, lacking features to counter the holistic effects of reduced physical activity.

3. Gamification in Fitness Recommender Systems

(Zhao, et al., 2020) demonstrated statistically significant improvements in user satisfaction through gamified, personalized systems. Descriptive analysis emphasizes features like goal-setting and storylines for sustained motivation. While apps like FitOn use social competition to engage users, they do not incorporate the adaptive gamification or tailored player modeling seen in advanced systems.

4. Diet Monitoring and Precision Nutrition

Statistical validation from (Abeltino, et al., 2024) supports the effectiveness of AI-powered diet-monitoring tools. Descriptive findings highlight challenges like data accuracy and engagement. Apps like MyFitnessPal cater to dietary needs but lack integration with precision nutrition technologies, presenting opportunities for innovation in combining AI and user-friendly interfaces.

5. Real-Time Feedback for Exercise Posture

(Hitesh, et al., 2024), provided statistical evidence of improved posture and reduced injury risks with AI-driven feedback systems. Descriptive analysis underscores the accessibility of such tools. Current apps, including Nike Training Club and FitOn, do not offer real-time pose correction, demonstrating the need for advanced technologies like FitSight to democratize professional-level fitness training.

6. Non-Contact Monitoring Using Computer Vision

(Salik, et al., 2022) showcased statistical evidence of accuracy in non-contact monitoring methods like video-based photoplethysmography. Descriptive analysis highlights their potential for fitness and remote health management. However, apps like JEFIT and Strong remain focused on manual tracking and lack integration with such innovative technologies, limiting their scope in comprehensive health monitoring.

3. Conclusion

The reviewed literature and applications reveal the transformative impact of technological advancements in fitness monitoring, physical activity management, and health improvement. While current tools demonstrate significant potential, their effectiveness varies based on features and user engagement mechanisms.

Pose estimation accuracy remains a critical challenge, as highlighted by MediaPipe Pose's limitations in suboptimal conditions. This emphasizes the need for advanced validation frameworks and robust technologies to enhance reliability, particularly in health-critical scenarios. Real-time feedback systems, such as FitSight, have shown promising results in improving exercise form and reducing injury risks, demonstrating the potential of AI-driven tools in democratizing professional-level fitness training.

The COVID-19 pandemic further underscored the value of digital fitness solutions in mitigating the adverse effects of restricted movement and increased sedentary behavior. Applications like MyFitnessPal provided accessible tools for maintaining physical activity and dietary habits. However, most apps fail to integrate real-time pose correction or gamification, which could significantly improve user engagement and long-term adherence.

Gamified systems and AI-powered diet-monitoring tools have demonstrated statistically significant improvements in motivation and precision, respectively. Features such as personalized recommendations, adaptive player modeling, and precision nutrition planning represent critical areas for further innovation. However, challenges like data accuracy, affordability, and user engagement remain barriers to widespread adoption.

Finally, non-contact fitness monitoring using computer vision offers a promising alternative to traditional sensor-based approaches. These technologies have broad applications in fitness, rehabilitation, and remote health monitoring, but environmental factors and motion artifacts present ongoing challenges.

In conclusion, integrating advanced pose estimation, real-time feedback, gamification, and AI-driven personalization into fitness applications could revolutionize the industry. Bridging the gaps identified in existing tools will enhance accessibility, engagement, and effectiveness, paving the way for a more inclusive and impactful fitness technology ecosystem.

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