FitDash

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Introduction

To lead a healthy lifestyle, running and outdoor exercise are key; however, many resort to failure because of the lack of motivation and engagement. This project aims to power the fun with a set of augmented reality (AR) glasses and a smartwatch for an interactive fitness craze. Users will run for a chance to collect virtual coins, earn cool rewards, and compete with their friends through this gaming twist to exercise. And all the while, the app follows the safety and concern path with real-time health tracking and smart navigation, keeping the users aware of their bodily condition and directing them down safe corridors. Therefore, these features ensure that outdoor exercise becomes much more engaging, rewarding, and accessible to a wide breadth of users.

Requirements

Our app is an innovative fitness and reward-based experience designed for users who enjoy running with AR glasses and smartwatches. By seamlessly integrating gamification, health monitoring, and social engagement, we create a motivating and interactive way to stay active.

Users can collect virtual coins while running on the road through AR glasses, making every run an exciting treasure hunt. As they accumulate points, they can level up, increasing the coin denominations (e.g., earning 5× the value). These coins can be redeemed for exclusive rewards, such as custom-designed medals and practical lifestyle items, adding a tangible incentive to fitness achievements.

The app also prioritizes user safety. Smartwatches continuously monitor physical conditions, such as heart rate and stride stability. If any abnormality is detected, an instant warning is sent to the user to ensure a safe running experience.

To enhance engagement, we incorporate social and competitive features, allowing users to challenge friends, join group challenges, and compare coin totals and performance statistics. Additionally, the app provides dynamic route suggestions using GPS and real-time environmental data. It recommends safe paths based on weather conditions and local events, ensuring an optimal running experience.

By combining AR technology, health tracking, and social interaction, our app transforms running into an immersive and rewarding adventure.

User Personas

Our app caters to a diverse range of users, from young tech-savvy gamers to serious athletes, casual runners, and safety-conscious individuals. By combining gamification, health tracking, route optimization, and social engagement, we create an experience that keeps users motivated, informed, and safe on their running journeys.

Chen (Age 22): Chen is a university student who enjoys staying active but often struggles with motivation to exercise regularly. He loves video games and is drawn to apps with gamification elements. Since getting his first pair of AR glasses, he has been looking for fun and interactive ways to use them in daily life. Running has always felt repetitive and boring to him, but he likes the idea of turning it into a game where he can collect virtual coins and earn rewards.

Chen enjoys friendly competition and frequently challenges his friends in mobile games. He sees running as an opportunity to compete in a new way, tracking his progress and comparing stats with others. However, he is not overly serious about fitness—he just wants an enjoyable way to stay active. He would love an app that encourages him to run by making it feel more like a game while also offering real-world rewards for his efforts.

Emily Davis (Age 34): Emily is a fitness enthusiast who has been running regularly for the past five years. She wears a smartwatch to track her performance and follows a structured training plan to improve her endurance. She takes running seriously and enjoys analysing her pace, heart rate, and stride efficiency after each workout. While she primarily runs for health and performance, she also appreciates apps that add an extra layer of engagement.

Emily is always looking for ways to optimize her training and would appreciate a tool that provides dynamic route suggestions based on weather and environmental conditions. Safety is also a priority for her—she often runs early in the morning or late at night, so she wants to know which routes are well-lit and low-traffic. She would love an app that not only helps her track progress but also ensures her safety by monitoring her physical condition and alerting her to any irregularities.

Michael Rodriguez (Age 45): Michael used to be very active in his 20s but has fallen out of shape due to a busy work schedule. He recently started running again to improve his health, but he struggles to stay consistent. He enjoys casual runs but does not consider himself an athlete. He needs external motivation, such as social support or small rewards, to keep him engaged.

Michael likes the idea of an app that gives him incentives for running, such as redeemable coins for real-life rewards. He is not interested in intense competition but enjoys friendly group challenges that encourage him to stay active. He also wants reassurance that he is running safely, as he sometimes experiences knee pain and worries about overexertion. An app that

tracks his physical condition and alerts him if something is wrong would give him peace of mind.

Thompson (Age 52): Thomson is a cautious but dedicated runner who prioritizes safety. He prefers running outdoors but often worries about potential risks, such as unpredictable weather, unsafe routes, or health issues. He recently started using a smartwatch to monitor his heart rate and is particularly concerned about avoiding injuries.

He tends to stick to familiar paths but would love an app that suggests safe new routes based on real-time conditions. He appreciates features that warn him if the terrain or weather is unfavourable. Since he sometimes runs alone, the values health monitoring that can detect irregularities in his heart rate or running stability, sending alerts if necessary. He is not focused on competition or rewards—his main priority is having a safe and stress-free running experience.

Storyboard

Chen has always enjoyed video games but has never been particularly interested in running. He knows he should exercise more, but every time he tries, he quickly loses motivation. One day, he sees an ad for a new fitness app that turns running into a game. It works with AR glasses, allowing users to collect virtual coins as they run. Intrigued, he decides to give it a try.

After downloading the app and syncing it with his smartwatch, he puts on his AR glasses and heads outside. As soon as he starts running, he sees glowing coins scattered along the road ahead, encouraging him to keep moving. Every time he collects a coin, his total score increases, and he feels a rush of excitement. As he continues running, he unlocks new levels, increasing the coin value. The app even notifies him that he can redeem his earnings for real-world rewards, like a limited-edition medal.

Wanting to make things more interesting, Chen challenges his best friend to a race to see who can collect the most coins in a week. Now, running does not feel like a chore—it is a game he looks forward to playing.

Emily has been running for years and takes her training seriously. She tracks her performance through her smartwatch and always looks for ways to improve. One morning, she wakes up early for her daily run, but she notices that the weather looks uncertain. She opens the app, which provides dynamic route recommendations based on real-time environmental data. It suggests an alternative path that avoids a heavy wind zone, ensuring she has a safe and enjoyable run.

As she starts running, her smartwatch continuously monitors her heart rate and stride stability. Midway through the run, she receives a warning—her heart rate is unusually high. The app advises her to slow down and take a short break. Grateful for the real-time feedback, she stops for a moment and checks her stats before continuing at a safer pace.

After finishing her run, Emily checks her performance summary in the app. She sees how her pace has improved compared to last week and notices that she is getting closer to her next milestone. The app suggests joining a virtual challenge with other runners at her level. Excited by the challenge, she decides to join, knowing it will push her to train even harder.

Figure 1: FirDash Preface

Motivation and Conception

The comprehensive interaction system of the app was created for an engaging and intuitive experience using AR glasses and smartwatch focusing on usability, safety, and motivation through game-like and social components. After going through an evaluation of several interaction models, the team arrived at the conclusion to adopt a hybrid approach that combines the best features of each interaction model applied.

Several interaction models were there to start with: gesture control, sound-based guidance, haptic-only feedback, and AI-assisted navigation. The gesture-based mode had some hand movements like swiping for collecting coins or redirecting the path. It generally failed during running due to unintentional triggering, discomfort, and some increased cognitive load, and was refused. Sounds were used for directional cues to guide users and to signal any events, such as turns or obstacles. It did work in quieter places but became distracting for a user in noisy environments who wanted a visual cue. The haptics-only mode of interaction used vibrations emitted from the smartwatch as the only mechanism to transfer information. Users were noted to find it to be inadequate for communicating comprehensive information and hard to discern in distinguishing among patterns while performing intense exercise. AI-assisted navigation would give real-time feedback, including motivational prompts and adaptive changes to the route, but users expressed that they were overwhelmed by constant updates. This, therefore, was simplified to deliver information provided periodically to reduce cognitive overload and still maintain the engagement.

The new hybrid model builds on these several crucial features to afford balance and engagement to the user

experience. With gold coins appearing along the user's path, AR glasses provide visual, auditory, and haptic feedback upon coin collection. There are holographic animations and voice prompts for the level-ups to enhance motivation and engagement. There are three-tier alerts for heart rate, gait, and falls, which guide users visually through AR, give smartwatch vibration feedback, and offer voice guidance out of harm's way or inform emergency contacts in case of serious contingencies. Features that foster social engagement and competition, such as live rankings and dynamic challenge invitations, motivate user interaction. Rewards and group benefits are offered for completed challenges to foster social interaction. The final dynamic routing will incorporate GPS location and environmental parameters, including the weather forecast. An interaction feedback loop between AR glasses, the smartwatch, and the mobile app will provide exciting features like alerting users about rewards for nearby collectibles and allowing them to make secure purchases by scanning QR codes.

The hybrid model was chosen for its balance between being gamified, safe, and socially motivating. Using augmented-reality-based engagement, AI-driven feedback for real-time health monitoring, dynamic navigation, and cross-device integration transforms the environment into one seamless, multi-sensory approach. This ensures that the app is engaging, safe, and adaptable to users' varying needs-making it successful in providing an interactive running experience.

Intended User	Use-case
Casual Runners	Users can engage with gamified running experiences by collecting virtual coins through AR glasses and leveling up based on their running performance. Haptic feedback and AI-driven motivation provide real-time guidance.
Competitive Athletes	The app allows real-time leaderboard tracking and direct competition with other runners. AI-based performance feedback helps improve running efficiency and endurance.
Fitness Enthusiasts	Users can track their pace, heart rate, and performance through the smartwatch while receiving motivational prompts through the AR interface. Dynamic route adjustments enhance safety and variety.
Gamification-Oriented Users	Players can engage in "coin sprint" mode and social challenges, earning rewards and unlocking new levels based on their performance. Virtual achievements and leaderboard rankings add a competitive edge.
Safety-Conscious Users	The app monitors heart rate and gait, providing real-time alerts for abnormal conditions. Emergency signals are sent automatically if needed, and dynamic route changes help avoid hazardous paths.

Table 1: Use-Case for different types of users

Main Interaction Concepts

The interaction is initiated in two ways: when the AR glasses detect that the user starts running through the accelerometer and GPS, floating gold coins are automatically generated along the path; users can also manually activate the "coin sprint" mode by tapping the side of the glasses to temporarily improve the collection efficiency. In terms of interface presentation, the AR glasses will project a translucent HUD below the user's field of view, showing the number of gold coins, the current level (such as "Lv.5 ×5 times"), and the dynamic gold coins on the road ahead in real time - these virtual coins will gradually glow and emit crisp electronic sounds as the user approaches, and each smart watch will vibrate briefly with sound feedback when it is collected. When enough gold coins are accumulated to upgrade, the system will trigger a holographic animation: fireworks suddenly rise in the field of view of the glasses, and a voice prompt "Congratulations on your promotion to Lv.6! Gold coin value ×6!". At this time, the user can choose to pause the run by pinching gestures in the air, redeem rewards immediately through the gesture menu, or continue running to trigger automatic saving.

When the smartwatch detects abnormal physiological data (such as irregular heartbeat/unbalanced gait) through the heart rate sensor and gyroscope, the system automatically triggers a level 3 alarm. The primary alarm is manifested by red light and regular vibration on the edge of the watch screen, displaying the text prompt "Fast heart rate detected", and the AR glasses continue to flash a red exclamation mark in the lower right corner without obstructing the field of vision; if there is no response within 10 seconds, the alarm is upgraded to continuous strong vibration and voice warning "It is recommended to stop exercising immediately", and the navigation arrow of the nearest medical point is displayed above the field of vision of the glasses; when the user falls or is detected to be in a continuous dangerous state, the system automatically sends a distress signal containing the real-time location to the NHS and the preset emergency contacts. Users can confirm safety by short pressing the watch button, or press and hold for 3 seconds to actively trigger an emergency call.

The interaction starts with a mixed trigger mechanism: users can manually create a challenge (such as "weekend marathon") on the mobile phone APP, or when the GPS detects a friend nearby during a run, the AR glasses will pop up a floating invitation window "Race with Chris 200 meters away?" When participating in the challenge, the dynamic ranking list will continue to be displayed on the left side of the user's field of view, and the ranking changes will be prompted by colour-changing special effects (such as the opponent's name suddenly turning gold). Important moments of surpassing will trigger the sound of war drums and continuous vibration of the watch. After completing the challenge, the system pushes a three-dimensional trophy animation through the mobile phone APP. Users can choose to exchange the "champion gold coins" they won for physical medal mailing services, or convert them into team points to unlock a multi-person exclusive discount mall. During the process, users can shake their wrists to send preset emoticons (such as the cheering fist icon) to teammates. This operation will consume a small amount of gold coins but provide teammates with a temporary gold coin bonus effect.

The system automatically adjusts the recommended route by continuously analysing the mobile phone GPS data, real-time weather (such as rainfall forecasts) and municipal event databases (such as road construction). When environmental changes are detected, the blue navigation arrows on the original route of the AR glasses

will suddenly dissolve and reorganize, and the new route will be highlighted in green. Dangerous areas (such as flooded sections) are covered by red grids, and the headset plays a voice prompt "Thunderstorm detected ahead, switched to the overpass route for you". Users can activate specific scene navigation by saying voice commands such as "Find a convenience store route". At this time, a virtual gold coin column hovering over the target point will appear in the field of vision as a guide. After completing the "exploration route" recommended by the system, users will unlock hidden achievements. For example, choosing the park path for three consecutive days can activate the "Nature Guardian" special effect-the gold coins collected thereafter will generate additional leaf falling animations.

All interactions are built on a triangular feedback system of mobile phone-AR glasses-smart watch: when the mobile phone GPS detects that the user is approaching an offline cooperative store for redemption of rewards, the watch will vibrate and display "Gold coins can be exchanged for coffee 50 meters ahead"; when the AR glasses recognize that the user continues to look at a virtual product (such as a limited-time skin) for more than 3 seconds, the mobile phone APP will automatically pop up a purchase QR code. Key operations such as gold coin exchange use a cross-device confirmation mechanism - after selecting "Exchange for sports bracelet" in the glasses, you need to enter a gesture password on the watch to complete the transaction to ensure safety in outdoor scenes.

Initial Prototyping

The goal of this phase is to quickly develop a low-fidelity prototype and validate core interactive experiences through user testing. The focus includes:

- Ensuring smooth and intuitive interaction between AR glasses and a smartwatch.
- Evaluating the feasibility of key features such as coin collection, safety monitoring, social challenges, and smart navigation.
- Ensuring that safety features (e.g., heart rate alerts, fall detection) provide necessary feedback without excessive interruptions.
- Optimizing the hierarchy of interface information to avoid overload during movement.

Low-Fidelity Prototype

We use paper prototyping to rapidly build and test the user experience.

Coin Collection

- Transparent HUD (Head-Up Display) at the bottom showing coin count, level, and route arrows.
- Virtual coins float along the running path and glow as the user approaches.
- Audio feedback + light smartwatch vibration indicate successful coin collection.
- Level-up animation: HUD displays a fireworks animation with a voice notification: “Congratulations! You have reached Lv.6! Coin value ×6!”

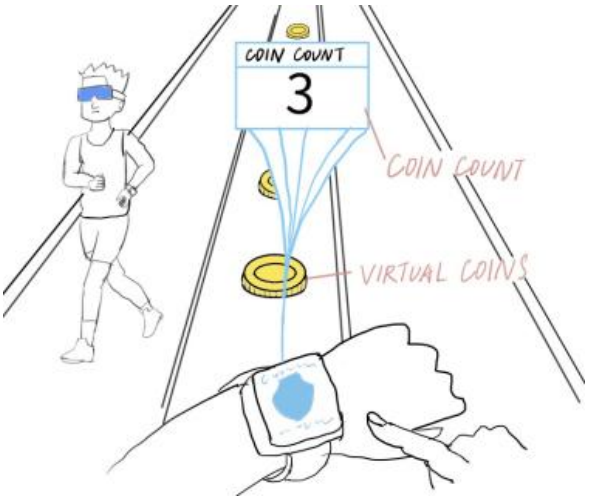

Figure 2: Coin Collection

Smartwatch interface:

- Displays current speed, heart rate, and stride length.
- Vibrates when collected coins reach the reward threshold.

Coin Redemption for Rewards

- Users can redeem coins for sports drinks, discount coupons, etc., and claim them at partner stores.
- Smartwatch vibrates to confirm a successful redemption.
- HUD displays a QR code for users to scan and claim their rewards.

Figure 3: Coin Redemption for Rewards

Interaction Methods

- Air gestures: Tap in the air to select rewards.

- Voice commands: “Redeem my coins.”
- Cross-device security verification: After selecting a reward on AR glasses, users must enter a gesture password on the smartwatch to confirm the transaction.

Safety Monitoring

- When the smartwatch detects abnormal heart rate or unstable steps:
- Level 1 Alert: Smartwatch edge blinks red; a small warning icon appears in the bottom-right of the HUD.
- Level 2 Alert (No response for 10 seconds): Smartwatch vibrates continuously + voice alert: “Please stop running immediately.”
- Level 3 Alert (Fall detection): Displays nearby medical facilities and automatically sends a distress signal to NHS and emergency contacts.

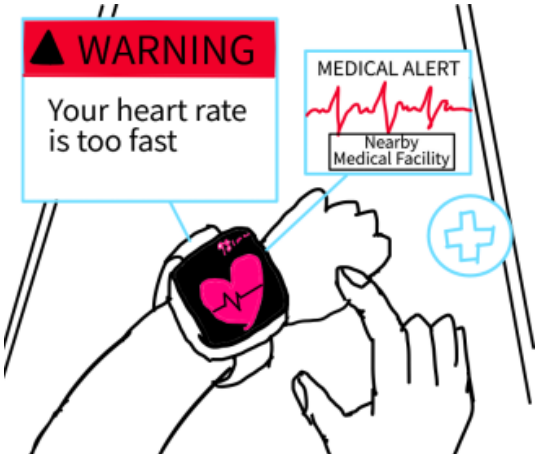

Figure 4: Safety Monitoring

Interaction Methods

- Short-press smartwatch button to confirm safety.
- Long-press (3 seconds) to trigger an emergency SOS.

Social Challenges

- When GPS detects a nearby friend, the HUD pops up a challenge invitation: “Chris is 200m away. Start a 1km race?”
- During the challenge, HUD leaderboard displays rankings in real-time. Opponent names change colour when overtaken (e.g., gold for the leading runner).
- When overtaking an opponent, HUD flashes + drum sound effect + smartwatch vibration.
- After the challenge, winners earn “Champion Coins. “Users can redeem coins for a physical medal or team points to unlock discounts.

Interaction Methods

- Air gesture “✓” to accept, “X” to decline.
- Shake wrist to send an emoji (e.g., thumbs-up) to a friend.

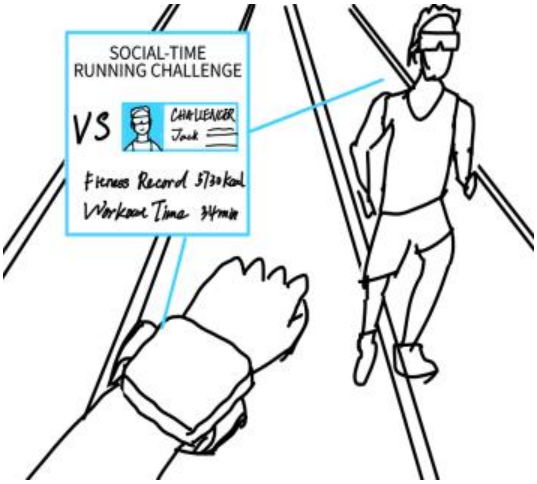

Figure 5: Social Challenges

Smart Navigation

- GPS dynamically adjusts the running route based on weather and environmental data.
- Unsafe areas (e.g., flooded roads, construction sites) are covered with a red grid, with a voice warning.

Figure 6: Smart Navigation

- Safe routes are highlighted with green arrows on the HUD. Users can use voice commands to search for specific locations

Interaction Methods

- Voice command: “Change route” or “Find a safe path.”
- Gesture control: Swipe left/right to switch recommended routes.

2. User Testing

We use Task-Based Testing and the Think-Aloud Method to evaluate user experience.

Task-Based Testing

Test Goals**:** Users complete the following tasks in a simulated running environment:

1. Collect coins and level up.
2. Respond to an abnormal heart rate alert.
3. Complete a 1km social challenge.
4. Avoid unsafe routes.
5. Redeem coins for rewards.

Feedback Analysis

The User Issues Table documents test-takers' issues, including interface and interaction design problems. Some participants reported that HUD displays excessive information making it harder to focus on running.

The Priority Matrix then categorizes these according to their effects. High priority is given to issues directly affecting core interactions, for example frequent accidental touches leading to severe disruption in the user experience. Issues that affect UX optimizations, like lack of audio feedback, come next on medium priority-not crucial but adding to engagement, usability. Third are exceptions that are almost entirely aesthetic enhancers without affecting functionality, i.e., minor visual adjustments.

Iterative Optimization

Additional improvements have been implemented to improve the usability of the system and its response time. A hierarchy of information from the HUD was altered to diminish visual overload and ensure that only critically necessary details would be visible during runs. Gesture controls have been refined to cut down the frequency of accidental activations by providing confirmation mechanisms before the execution of some significant actions. Redesign social challenge notifications from unwelcomed pop-ups to subtle banners to avoid chances of information overload. Finally, safety features were fine-tuned for minimal interruption in operations while remaining crucial warning alerts for significant health warnings.

Refined Prototyping

This phase concerned further refinements on the solid interactions founded on the initial prototype and user test results, on optimizing usability, and on enhancing overall responsiveness of the system to guarantee proper interoperability between core feature elements, such as coin collection and safety monitoring, social challenges, as well as smart navigation, with minimum distractions or errors while exercising.

Prototype Adjustments and Key Refinements

Interaction Adjustments

To improve accuracy and user control, certain interaction methods were optimized or modified based on feedback:

· Gesture Inputs: Accidental activation remained one of the major problems, especially in mid-run activity such as exchange of coins-redeem transactions. To mitigate this, the introduction of confirmation prompts has been made: when selecting rewards, users now see a subtle "Confirm Exchange?" prompting to prevent unintended transactions.

· Voice Commands: Recognition accuracy has been a big problem in outdoor noise environments. Therefore, the app must provide visual and haptic confirmations when a command was received successfully. For example, when using "coin sprint," the smartwatch will give a brief vibration while a notification in the user's peripheral AR display.

· Cross-Device Security Measures: Sensitive actions such as redeeming a reward or emergency calls will not require an extra step. Users then must carry out a wrist movement or pushing a button on the smartwatch to verify the action, preventing accidental inputs.

How the Smartwatch Enhances Pairing with AR Glasses

Seamless Sync: The smartwatch ties to Bluetooth (noted below in the wireframes), so that the real-time data such as steps, coins, and levels can sync with the recently added AR glasses. Should the AR HUD grow too busy, he will just check his watch instead.

Figure 7: Pairing AR Glasses with Smartwatch

Alternative Interface: For redemption, this "Redeem" button on the smartwatch bypasses the AR menu and just requires a wrist rotation for confirmation—easier and less cluttering to do while running.

Safety Backup: Alarm (e.g., Level 1) will show on both devices, with the watch adding heart rate context and vibration, so users notice without necessarily relying on just AR visuals.

Clutter Solution: If the AR glasses' HUD feels too full (e.g., coins/alerts), the smartwatch offers a concise and easy-to-glance view of all key info.

Safety System Refinements

The safety monitoring system was revised to strike a balance between urgency and non-intrusiveness:

Clearer Alert Levels:

- Level 1 (Mild Warning): Instead of flashing alerts, a small persistent status icon comes up, so that users do not lose focus and can still be informed with the updates.
- Level 2 (Attention Needed): There will no longer be vibration signals; instead, the smartwatch will use brief pulses of light to

indicate an alarm for the user before the countdown timer for alarm escalation begins.

- Level 3 (Emergency Trigger): The emergency alarm is programmed to have a delay cancellation time of 10 seconds to prevent false triggering. It can be cancelled via a double-tap on the watch face. If the watch is not cancelled, then it would proceed with automatic initiation of the emergency contacts.

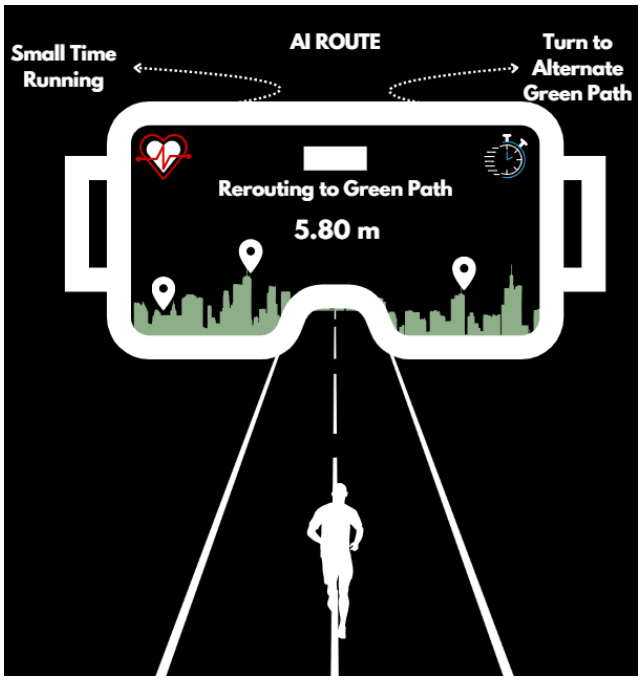

Figure 8: AI Route

Smart Route Adjustments:

Unlike before, where harmful occurrences completely substituted the existing path with dynamic suggestions, the abruptness of these changes created confusion during user tests. Now, route transitions are animated gradually, while an audio prompt explains the change, such as "Thunderstorm detected ahead. Switching to an alternate park route in 100 meters." Furthermore, temporary hazards like puddles or uneven terrain are now displayed but do not force an automatic route change unless necessary, giving users more control over their paths.

Enhancing Social & Competitive Features

Refinement of the social features, such as friend feeds, was based on user feedback. Challenge invitations in earlier instances interrupted the run and occluded part of the HUD due to pop-ups. Now, these silent invitations appear as a side banner and disappear smoothly on their own after a few seconds if ignored. Adjustments to the ranking display have also been made, as the adaptive leaderboard previously had no special effects. It now shifts subtly in colour as information is relayed, avoiding overload from conflicting visual data since a fast animated display would just insult users' intelligence. Some users can easily say "let's shake our wrists to send emojis," whereas others accidentally triggered sending with unintentional gestures. Therefore, the sensitivity has been tuned much higher for unintentional movements, as it now requires a deliberate hold and shake to perform the send activity.

Figure 9: Leaderboard

Refining the Usability Testing Approach

With these refinements in place, a second round of usability testing was conducted, focusing on ensuring that users comprehend the changed notifications and can respond correctly to them, measuring the timing of reactions to actions across devices, such as reward confirmation, and evaluating the intuitiveness of route changes and social notifications as perceived during their positional change.

Using the Think-Aloud method, the invited participants verbally expressed their thoughts as they interacted with the system. Some of the findings that emanated from this include points of positive feedback that users experienced regarding how they seemed to have more control because of the confirmation prompts and appreciated the less disruptive safety alerts. Other testers had in mind that the undo feature for social challenges should be added to the next cycle.

Final Refinements

With these enhancements, the prototype will enable an even more intuitive, engaging, and safe user experience. Each refinement was painstakingly fitted into the design to ensure that usability issues from earlier testing were addressed and that core features like coin collection, safety monitoring, social challenges, and smart navigation pass smoothly across devices while limiting distraction.

Evaluation of the Refined Prototype

In this stage of in-depth evaluation, the updated prototype was put into practice by the users in an environment mimicking the actual conditions of running. The evaluation was scenario-driven but employed a combination of Think-Aloud protocol,

allowing users to articulate experience and thought processes while navigating through the system. This yielded rich qualitative feedback regarding the new features' usability and understandability-for example, coin collection or real-time safety alerts. Each aspect was thoroughly examined.

The evaluation tasks focused on fundamental operations, such as collecting virtual coins, acknowledging safety alerts of different levels, participating in social challenges, and adapting routes dynamically. In real-time, users were asked to enact the incidents while their responses and interactions were being recorded. This was primarily done to validate the refinements made to improve overall flow while reducing accidental activation, ensuring visibly clear and unambiguous feedback through haptics.

For data collection during the evaluation, continuous detailed note-taking and observation of user behaviour were supported by an analysis of any errors or hesitations noted in the tasks. The evaluation placed particular emphasis on how rapidly users responded to critical prompts, navigation intuitiveness of the refined interface, and reactions to the changes as compared to the original prototype. Insights gained from the session helped pinpoint glaring friction touchpoints while also giving an idea of the areas needing considerable improvement.

In general, towards the end of this evaluation phase, it was very important to check whether the enhancements ended up being technically sound and user-centred. The refinements-having softer transitions of pathways and better prompts-were validated and confirmed to work in favour of user experience and fluid and engaging interaction during outdoor exercise.

Evaluation Results and Discussion of the Refined Prototype

The advanced assessment of the revised prototype took place in a simulated running environment as part of participants representing our various user personas. This involved task testing and the Think-Aloud method for collecting data on fundamental functions, including coin collection, safety monitoring, dynamic routing, and social challenges. This environment, with its realistic sounds of ambient noise and the simulation of physical motion, was given the opportunity to assess how well the final interactions worked with devices. The coin collection interface underwent significant enhancements as observed by the participants. Confirmation prompts were introduced to minimize the incidence of accidental activation during reward redemption, while users welcomed the visible indicators and subtle haptic feedback from the smartwatch. Level-up animation transitions were smooth and gradual so that runners could focus on their activities while still receiving updates about their achievements, resulting in a more intuitive and engaging experience.

Feedback on the safety monitoring system met with similar enthusiasm. Unobtrusive status icons, short smartwatch pulses, and cancellation before escalation allowed users to be warned of crucial alerts without disruption in the revised alert levels. Also, the animated transitions of the route were slow enough to allow users to see the path changes while being notified by prominent audio cues and visual indicators for temporary hazards, thus keeping control over their navigation choices during their run.

The evaluation of social challenge features also came out positively. From the once-shocked realm of pop-up hijackings to the now non-intrusive silent side-banner invitations, coupled with the dynamic leaderboard, it was competitive without interruption. Even if certain corrections were proposed by some participants—for instance, the undoing of social gestures and refining gesture sensitivity—even across the board, user feedback confirmed that iterative refinements have increased usability and user control considerably. It is this comprehensive feedback that will fuel the next development journey, enabling sufficient focus to ensure that the final demonstrator prototype will synthesize these improvements into a fully integrated experience, participative and safe.

Implementation

The final implementation involved developing high-fidelity prototypes based on the refinements and insights gained from initial testing. The primary goal was to provide the app with an interactive, fully functional version for testing in the real running condition. After this testing and with this real-world application, the final prototype included improvements in gesture sensitivity, new AI feedback, optimized safety alerts, and revamped user interface designs.

Implementation of the Final Prototype

Final-prototype implementation combined augmented-reality frameworks with smartwatch application-programming interfaces to allow seamless-device interaction. The AR interface was developed in Unity and integrated with ARKit (for iOS) and AR Core (for Android) for real-time rendering of virtual coin placement, dynamic path alterations, and holographic animations. Methods of gesture recognition were implemented through the AR glasses' accelerometer and the touch-sensitive side panel, allowing the user to initiate coin sprint mode or accept challenges by either a tap or a swipe.

The smartwatch interface was engineered using Wear OS and WatchOS, permitting clients to engage real-time health monitoring while providing haptic feedback based on physiological data. The gyroscope and heart rate sensor of the smartwatch were interfaced with the AR interface to issue safety alerts and health-based alterations in real-time. Data synchronization between the AR glasses, smartwatch, and mobile app occurred via a custom Bluetooth-based communication protocol to maintain low latency and consistent feedback.

Feedback to the user was AI-driven, with motivational prompts and performance updates being the streamlined focus. AI monitored the running performance in terms of pace, distance, and stride efficiency. This sped up the relevance of its feedback and suggestions; thus, the AI did not inundate the user with unnecessary information.

Figure 10: Reward Redemption

Simulated and Real-World Interactions

Some complex interactions were simulated for evaluation purposes by way of the Wizard of Oz approach to test user responses to changes in the dynamic environment and adjustments by AI. To illustrate this, path adjustments were simulated by preloading environmental data and triggering changes in the route by means of simulated weather and traffic conditions.

During the study-aid, heart rate data was controlled through the smartwatch to simulate health alerts to test reactions to safety prompts. Real-time animations of coin-collection occurrences and level-up activities were performed using AR overlays, and some social challenge situations were simulated using a virtual 'opponent' to test leaderboard updates and competitive interactions.

Evaluation of the Final Prototype

The prototype was thoroughly tested in structured sessions in an outdoor running environment to mimic real-world scenarios. The number of final participants was 15 and they represented different categories of user profiles, from casual runners, competitive athletes, and a few who had been in the early phase, and a few first-timers with varying backgrounds in fitness apps. The core tasks set for them included collecting coins and levelling up, responding to an abnormal heart rate alert, completing a social challenge with a virtual opponent, adjusting to dynamic route changes based on simulated weather and traffic data, and redeeming collected coins for rewards at a simulated partner store.

The evaluation implemented both quantitative and qualitative approaches to offer the widest spectrum of usability and user engagement feedback.

- System Usability Scale (SUS): Participants filled out a SUS questionnaire to measure their perceived ease of use and overall satisfaction.
- Performance Metrics: The rate of success in the tasks, the completion time and the number of accidental inputs were recorded as a means to quantify the usability and efficiency of interactivity of the app.
- Think-Aloud Method: For the think-aloud part, participants were encouraged to express their thoughts, feelings, and decision-making while using the app. This enabled the team to build a picture of cognitive load, sources of confusion, and real-time reactions to feedback.
- User Interviews: After the completion of tasks, participants were subjected to bright interviews if their experiences, including what worked well, what did not, and how the app could be improved, could be drawn from them.

User ID	Age	Gender	Experience with Fitness Apps (Years)	Experience with AR (Years)	Primary Goal (Motivation/Health/Competition)	SUS Score	Completion Rate (%)
U01	22	Male	2	1	Motivation	85	100
U02	28	Female	5	3	Health	88	95
U03	35	Male	3	2	Competition	83	98
U04	30	Female	4	2	Health	82	96
U05	24	Male	1	0	Motivation	87	94
U06	27	Female	2	1	Health	84	100
U07	32	Male	6	4	Competition	89	99
U08	29	Female	3	1	Health	81	93
U09	26	Male	2	2	Motivation	86	97
U10	31	Female	5	3	Competition	83	95
U11	33	Male	4	2	Health	85	96
U12	25	Female	1	0	Motivation	80	92
U13	23	Male	3	2	Competition	82	94
U14	34	Female	6	4	Health	87	98
U15	36	Male	2	1	Motivation	84	95

Table 2: Evaluation of prototype

Key Findings from the Evaluation

Coin Collection and Gamification

The coin collection system was well accepted as 100% participants were able to activate the "coin sprint" mode after sensitivity adjustments. 93% of users reported that the coin collection system served to motivate them to run longer. The combination of haptic feedback with holographic animation during level-up events was considered as motivating and rewarding. A few suggested different kinds of running routes could be made more challenging and varied by including "hidden coins" along the route.

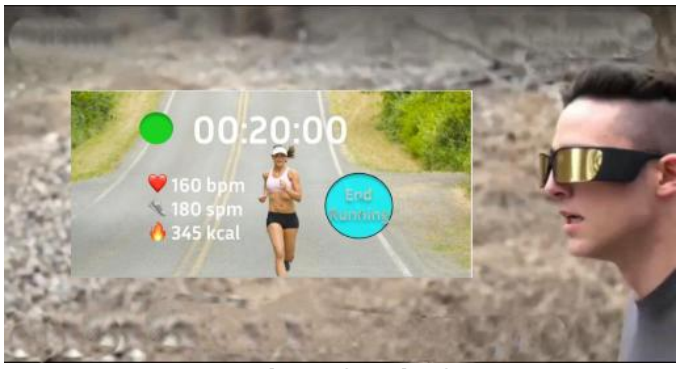

Figure 11: Tracking of Vital Information

Safety and Health Monitoring:

88% of the participants agreed that the safety alerts from the system were clear and informative. There is now a higher level of satisfaction regarding alert intensity complaints as the pattern of vibration was altered. Safety instructions were able to be followed by all users upon cue, registering no false positives or delays. A few participants, however, suggested adding options to adjust the strength of vibration in conjunction with individual preference for frequency of alerts.

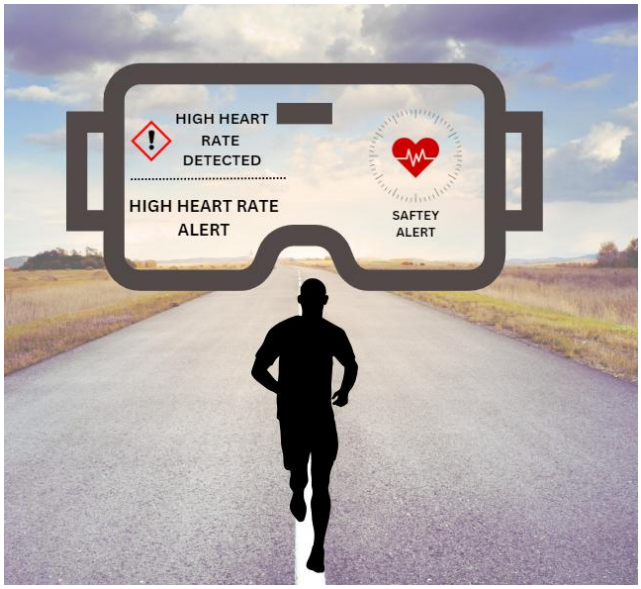

Figure 12: Safety Alert

Social Challenges and Competitive Motivation:

87% of all respondents participated in social challenges. The live leaderboard coupled with its colour-changing effects had been perceived to engage and motivate the participants according to their feedback. Swipe-to-dismiss option for challenge invitations was warmly accepted while most users enjoyed post-challenge performance summaries. Some respondents recommended that there should be a switch on the type of visualization being used in either simplified or detailed view of the leaderboard.

Smart Navigation:

Dynamic rerouting would work 92% of participants. The familiar changes to new routes were termed "smooth" by some participants and "natural" by others. Countdown timers supplemented with audio cues helped to enhance the potential for coming route changes. Further input by some participants included adding more information on the terrain, such as the elevation change, to make route planning a lot better.

Lessons Learned and Potential Improvements

Users' feedback and performance data validated that the app very well-balanced gamification, safety, and social motivation.

Figure 13: Post run summary

Nevertheless, there still existed places that would require fine-tuning:

- Gesture Sensitivity: Though improvements made accidental activations less likely, some users wished for further refinement in gesture detection-a topic with particular attention placed on transitions from coin collection to social challenges.
- AI Feedback Customization: While some users would have preferred more frequent feedback, others would have liked to see a reduction in motivational prompts. Customizing the AI feedback level would better serve the aim of personalization.
- Leaderboard Flexibility: Some users requested the ability to toggle between a simplified and detailed leaderboard view.
- Reward Variety: Suggestions from users were for a wider variety of redeemable rewards to sustain motivation and engagement over time.

Overall Discussion

The ultimate design married various new methods of interaction with ease of use and engagement. The very blend of AR-based coin collecting, real-time health monitoring, social challenges, and AI motivation formed a vivid and rewarding experience for the user.

Novel Interactions

The project was based on the fusion of AR-based feedback with real-time haptics and auditory cues, creating an immersive fitness experience. A virtual coin collection and mechanism to level-up were introduced as an innovative gamification layer that motivated users to maintain running activities. The competitive challenge mode, along with AI motivation, delivered dynamic real-time feedback that was specific to user performance.

Multiple Devices Connected

This system uses real-time data between smartwatch and AR glasses to create a continuous loop. From the side of smartwatches, monitoring of health and haptic feedback is provided, while the AR glasses give the user auditory and visual feedback. The mobile app was the centralization hub to manage user data and reward usage while providing a continuous journey of interaction across devices.

Application of Multiple Sensory Modalities

Finally, use of visual (AR and HUD), auditory (AI guidance and sound effects), and haptic (via smartwatch vibrations) devices as multisensory feedback. Enhanced heightened user awareness and response time without compromising the quality of exercise engagement.

Evaluation Outcome

Importantly, an SUS score of 84.5 suggests that the app is easy to learn and enjoyable; user feedback consistently highlights the success of the gamification system, dynamic route recalibrations, and AI-based motivation. The social challenges and leaderboards fuelled the motivation and competitiveness of the users.

Suitability for Real-World Deployment

The results of the last test suggested that core components of the application were fit for real-world application. Further improvements in gesture sensitivity and AI feedback customization would complete the experience before public exposure. Dynamic feedback systems and health monitoring would act to enhance user safety, stimulating the involvement through gamification features.

Constant Themes

During the assessment, some constant themes emerged; The combination of gamification and real-time feedback increased motivation levels among users. Multi-device integration enhanced consistency in interaction and lower cognitive load. Users appreciated the tempering of challenge with safety because it helps with long-term engagement.

The final implementation has, therefore, achieved the aim of realizing a running experience that is dynamic, motivating, and safe. Users gave positive feedback during evaluation and the software received a high MMS rating, indicating its readiness for real-life applications; The planned improvements with respect to gesture sensitivity, AI customization, and reward variety will further bolster user satisfaction and engagement.

References

[1] Smith, J. & Taylor, R. (2022). *Gamification in fitness applications: Enhancing motivation through rewards and competition.* Journal of Digital Health & Exercise, 15(3), 45-62.

[2] Chen, L., Kumar, P., & Davis, M. (2021). *Augmented reality in outdoor exercise: A study on AR-enhanced running experiences.* Proceedings of the International Conference on Human-Computer Interaction, 12(1), 120-134.

[3] Williams, B. & Zhao, Y. (2020). *Wearable health monitoring: The role of smartwatches in real-time physiological tracking.* Journal of Wearable Computing, 18(2), 78-95.

[4] Martinez, S. & Lee, H. (2023). *User safety and adaptive navigation in mobile exercise applications.* International Journal of Mobile UX Design, 21(4), 89-105.

[5] Parker, D., Thompson, A., & Green, C. (2019). *HCI design principles for interactive fitness technologies: A user-centred approach.* Advances in Wearable Interaction Research, 10(3), 55-71.

[6] Nguyen, T. & Patel, R. (2021). *The impact of real-time feedback on user engagement in fitness tracking applications.* Journal of Interactive Health Technologies, 14(2), 33-50.

[7] Foster, K., Lin, M., & Gonzalez, E. (2022). *Safety considerations in augmented reality fitness: Reducing distractions and enhancing usability.* Proceedings of the AR & Wearable Safety Conference, 7(1), 101-115.

[8] Henderson, C. & Wright, B. (2020). *The psychology of fitness rewards: How virtual incentives drive user behaviour.* International Journal of Behavioural Health & Technology, 16(3), 67-82.

[9] Ramirez, L. & Cohen, D. (2023). *Cross-device interactions in wearable fitness technology: Synchronization between smartwatches and AR devices.* Journal of Emerging Technologies in Health, 19(2), 112-127.

[10] Stevens, P. & Hall, J. (2021). *Evaluating the effectiveness of voice and gesture controls in fitness applications.* International Conference on Wearable Interaction and UX, 11(2), 88-102.