Innovative Ultrasonic Motion Tracking for Fitness and Rehabilitation

Harnessing Generative AI and Ultrasonic Technology for Enhanced User Experience

22/Jul/2024

About AAEON Company & Genius Ultrasonics

- **AAEON (https://www.aaeon.ai/):**
  - **Expertise**: A leading expert in the Industrial PC sector.
  - **Products and Services**: Offers cost-effective, high-quality solutions and system integration services.
  - **Partnerships**: Maintains strong collaborations with leading high-tech companies, providing exceptional services and cutting-edge technologies to business clients.
- **Genius Holding (https://www.taiwanarena.tech/startups-detail/86/):**
  - **Core Technology**: Innovative ultrasonic motion tracking, and ultrasonic wireless technology.
  - **Applications**: Used in fitness and rehabilitation fields, providing precise motion tracking and exercise guidance.

Technology Integration:

- **Ultrasonic Motion Tracking**:
  - Utilizes low-cost ultrasonic emitters and advanced algorithms.
  - Only give microphone permissions on their electronic devicces, such as the smartphones, tablets and smart speaker, eliminating the need for complex Bluetooth or Wi-Fi configurations.
- **Generative AI System**:
  - Powered by Llama 3.1.1 (8b), offering strong language understanding and generation capabilities.
  - Provides user-friendly interfaces, natural language guidance, and real-time feedback.
  - Adapts to various user needs, beneficial for both fitness enthusiasts and individuals in rehabilitation.

Problem Statement

- **Inaccurate Tracking and Data Measurement:** Traditional systems often lack precision, leading to incorrect assessments.
- **Complex and Cumbersome Setups:** Many systems require complicated setups, discouraging consistent use.
- **Costs:** Advanced fitness and rehabilitation equipment is often expensive, limiting accessibility.
- **Limited User Engagement:** Existing systems often fail to engage users, leading to poor adherence to exercise and rehabilitation regimens.
- **Data Privacy Concerns:** Increased reliance on personal data raises privacy and security issues.

Innovative Solution: Ultrasonics and Generative AI

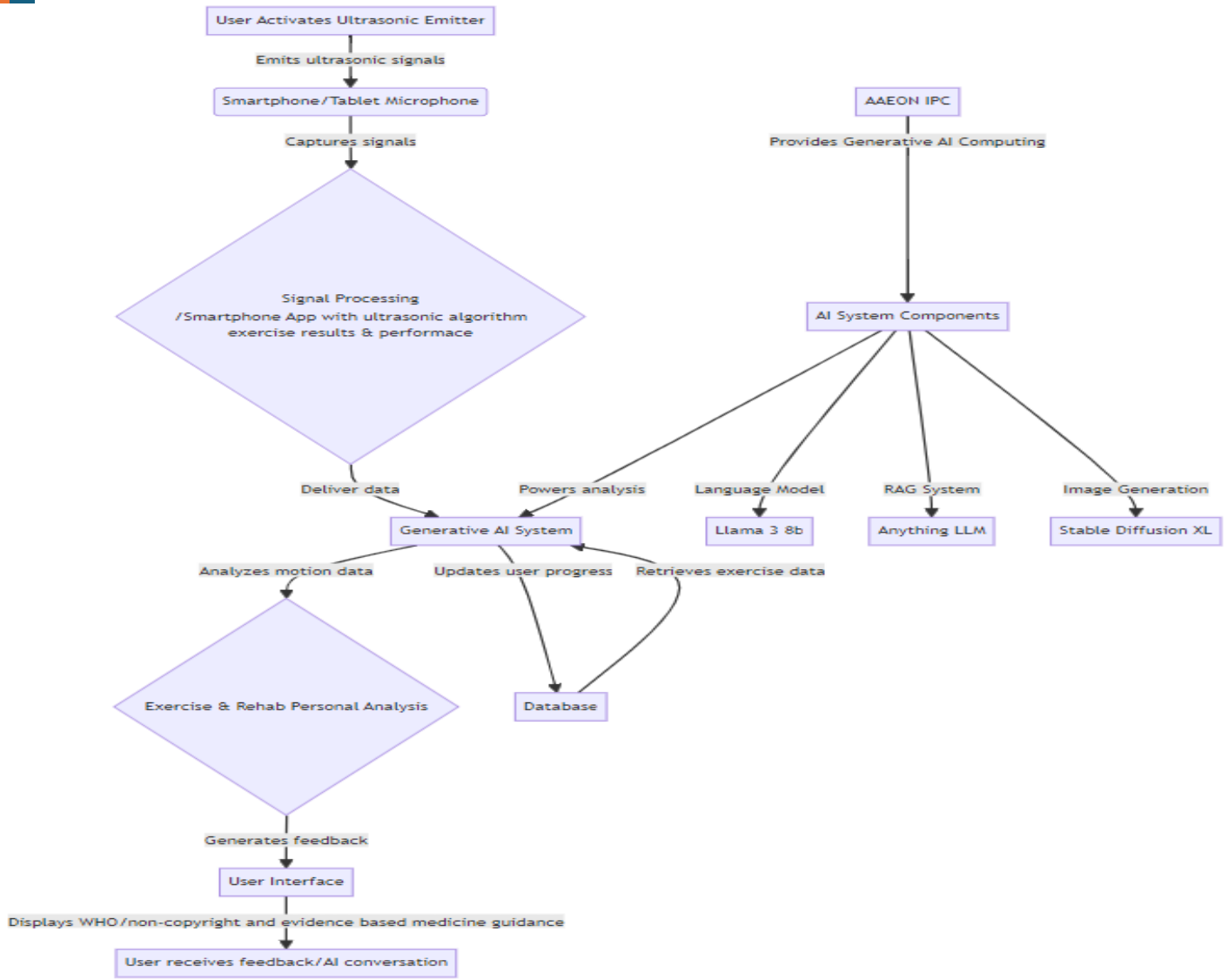
Ultrasonic IMU & wireless:

- Ultrasonic motion technology provides precise, real-time tracking of movements
- With microphone permission, simplifying setup and user-friendly.
- The low-cost ultrasonic emitters and users' smart electronic as the screen and hub provide an affordable, and accessibility.

Generative AI provides personalized interaction, feedback and advices

- **Anything LLM + RAG, and AIGC image:**
  - Offering personalized exercise recommendations, and accurate user progress tracking.
- **Meta Seamless Communication Models:** For voice input and output interface
  - Extends interaction to smartphone, tablet, and smart speakers, without manual operation.
- Data could be stored on the edge hardware when necessary. Robust data security measures protect user information, addressing privacy concerns and building user trust.

Innovative Solution: Generative AI Flowchart



Generative AI

- **Meta llama 3.1:** combination with ollama and anythingllm (or other advanced RAG agents)
- **Image Generation:** such as stable Diffusion XL(ControlNet for openpose, Lora for image quality and style)
- Reverse description with AI for corraction.

Innovative Solution: Generative AI Hardware

- Graphy card: >Intel Arc A750 (8GB), NVIDIA 3050 (8GB)
- RAM: > 16 GB
- CPU: > Intel i5, AMD Ryzen 5
- OS: Linux
- HD: >1 GB SSD
- Hi-res Microphone: > 48 kHz audio recording (96 kHz sampling rate)
- Ultrasound emitter: default 18~ 22 kHz ultrasonic emitter (500 Hz interval; for slow motion and 1~2 person use),
  and 22~44 kHz ultrasonic emitter (1 kHz interval; for high speed motion, multiple players)

Key Features and Benefits: LLM Intergration

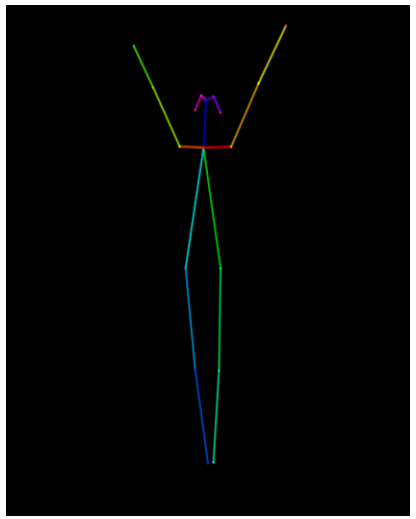
- **Primary LLM AI:** Meta Llama 3.1 for generating personalized responses.
- **Knowledge Database:** evidence based medicine, public without copyright issues materials from WHO or government guideline.
- **Retrieval-Augmented Generation (RAG):** Enables AI to access and utilize this specialized knowledge.
- **Content Review:** Another isolated LLM AI reviews responses for appropriateness before final output.
- **Voice Recognition & Text-to-Speech (TTS):** Uses Meta Seamless for multi-language voice-to-text conversion, convert text responses into voice outputs.

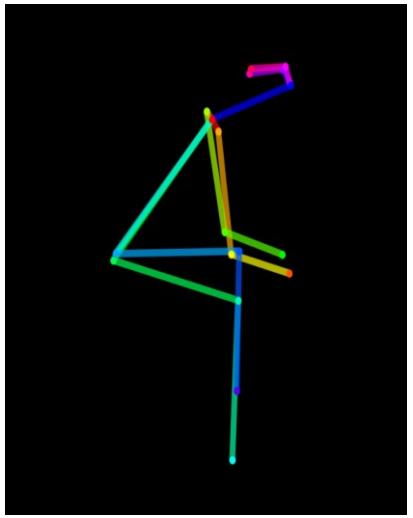
GitHub - 2noise/ChatTTS: A generative speech model for daily dialogue.
Welcome to GraphRAG (microsoft.github.io)

OpenPoses

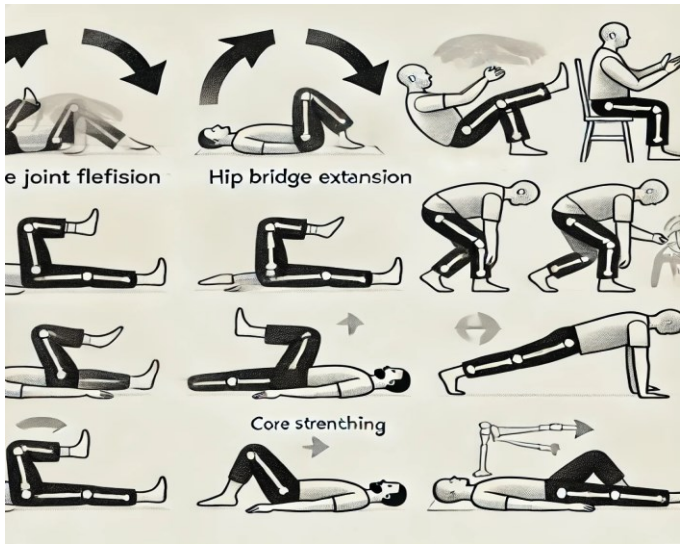
Key Features and Benefits: Visual Assistance AIGC

- **Stable Diffusion:** Generates standardized images for exercises, controlled via seed values.
- **ControlNet OpenPose:** Guides consistent body posture in generated images.
- **Animation:** Creates continuous motion images or videos to demonstrate exercises.





OpenPoses



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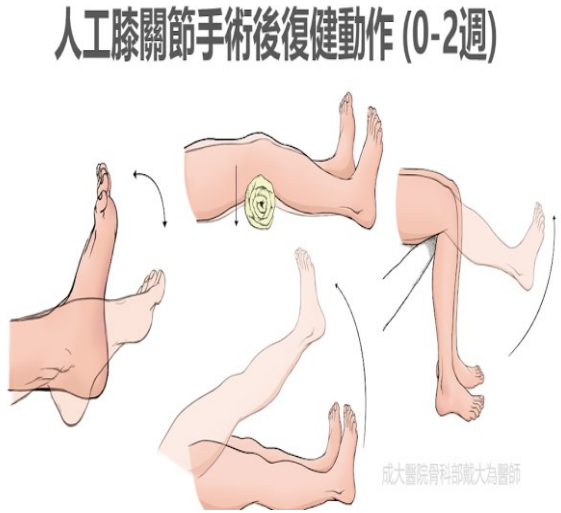


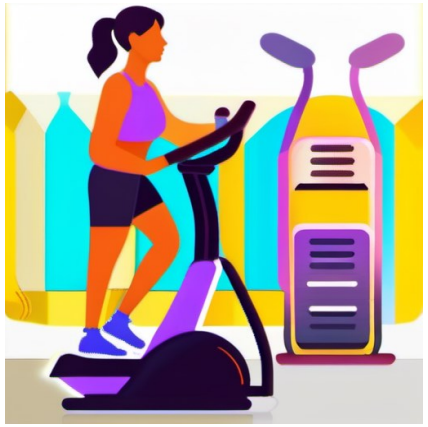
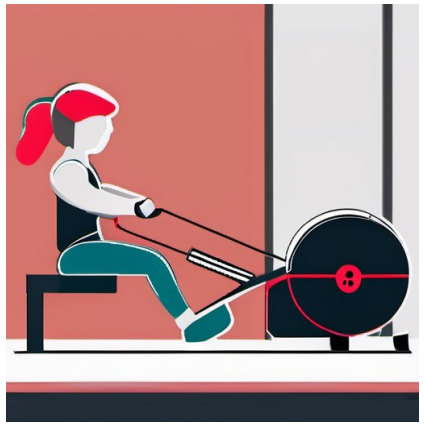
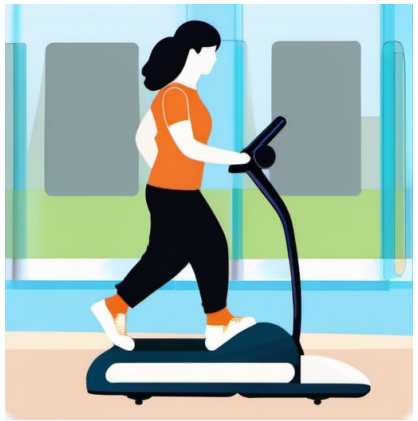
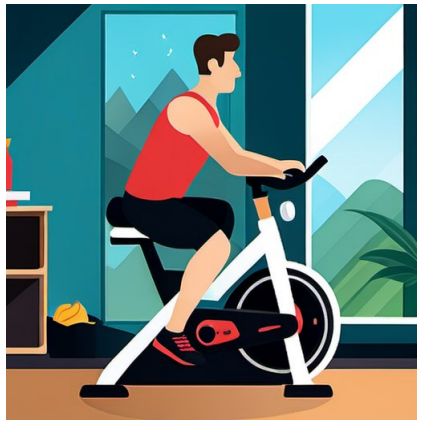
Traditional Draw

Key Features and Benefits: Personal Coach

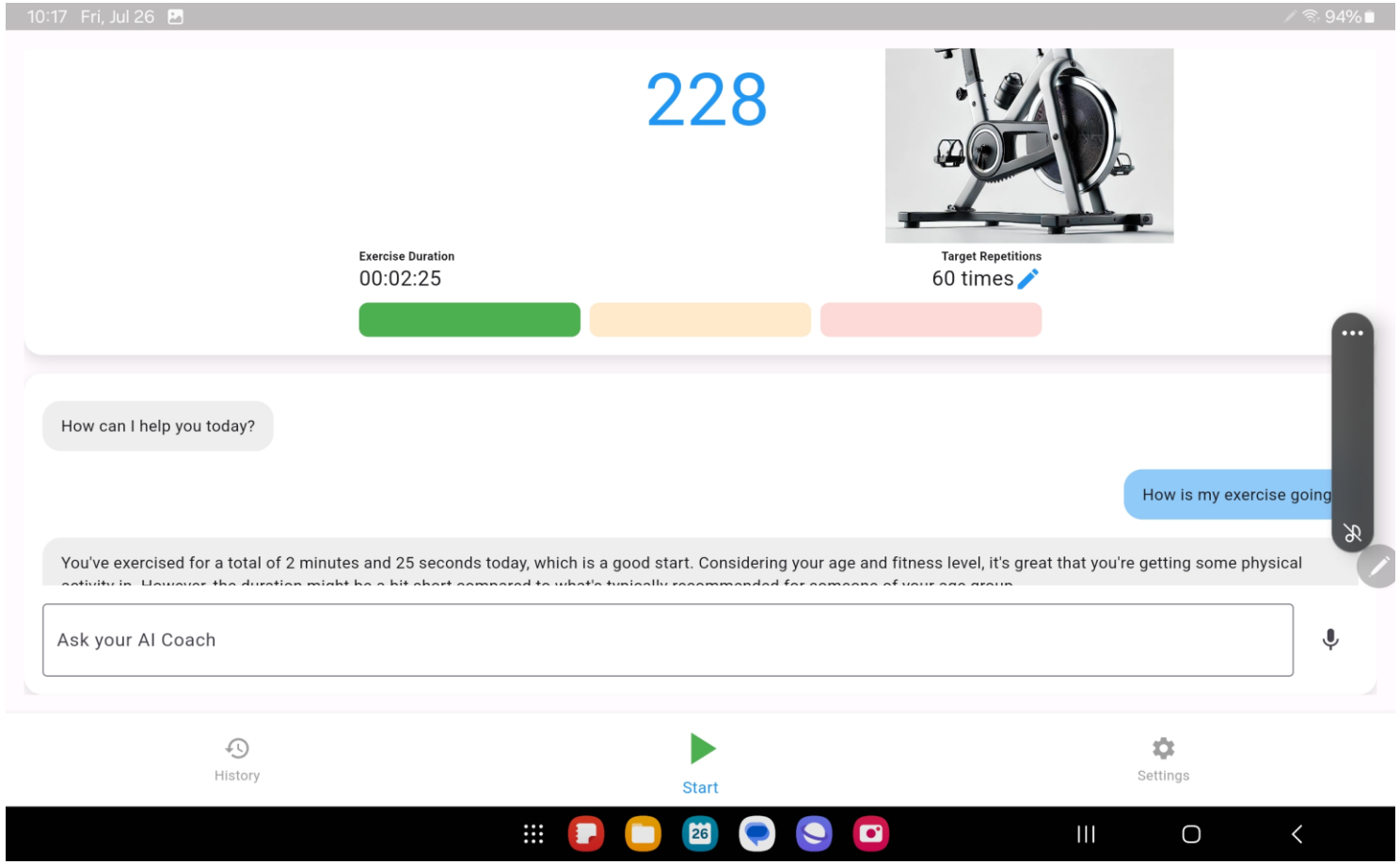
- **Personalized Assistance:** Tailored fitness and rehabilitation plans based on user interaction and health status.
- **Visual and Audio Guidance:** Enhances user experience with clear, demonstrative visuals and accessible voice instructions.
- **Innovative Movement Tracking:** Accurate and non-invasive monitoring of user movements without the need for cameras.

Technical Specifications and Use Cases

- **Ultrasound Transmitters:** Ultrasonic devices can be attached to key body points, such as the knee, wrist, or shoe, to capture movement data through ultrasound frequency shifts.
- **Microphone-Based Detection:** Integrates with audio feedback systems, utilizing frequencies beyond the typical environmental range. By placing a smartphone or tablet on exercise machines, it can track performance metrics.
- **Generative AI:** Personalized encouragement, communication, and advice for fitness and rehabilitation purposes.

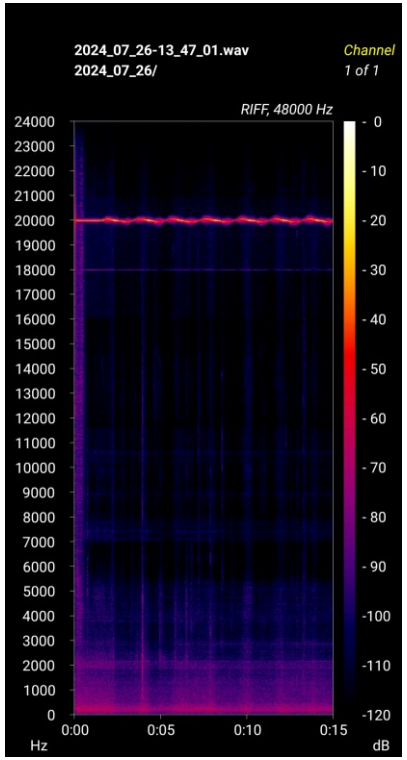





App & Use Cases

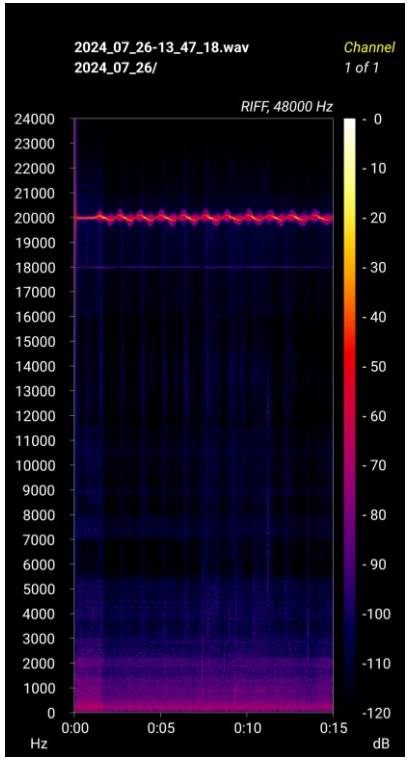


https://youtu.be/MKBsYrS7e_U

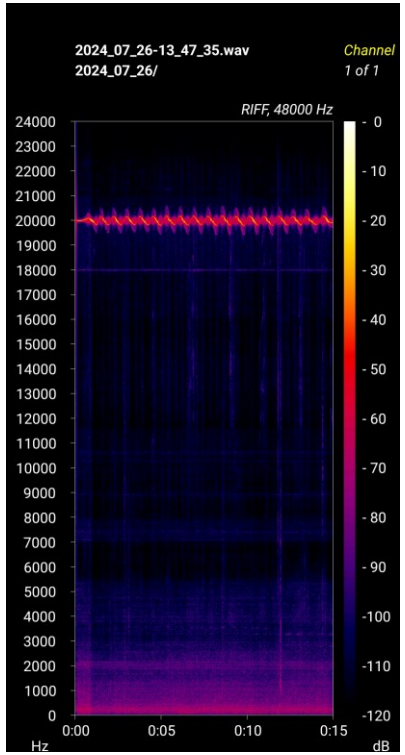
Key Features and Benefits: Realtime Motion Tracking



Slow



Medium



Fast

- Indoor Bike/flywheel exercise
- Fixed 20 kHz ultrasound as the motion tracker.
- Slow, medium, and fast motion will change the ultrasonic frequency shift.
- Background noise or musci will not distrupt the ultrasonic signals.

Strategic Partnerships

- **Meta:** brings cutting-edge AI technology with Llama 3.1, providing a core intelligent system for enhanced human-computer interactions. This technology supports real-time feedback and personalized guidance in various applications, including fitness and rehabilitation.
- **AAEON:** a well-established provider of industrial computer solutions, collaborates with leading IT companies worldwide. With its excellent system integration capabilities, AAEON enables the deployment of this generative AI system across diverse settings such as homes, gyms, and schools.
- **Genius Holding:** innovative ultrasonic wireless transmission and motion detection technology, offering cost-effective and user-friendly solutions. Their technology facilitates voice interaction and wireless data transmission via microphones, enabling accurate motion and rehabilitation tracking.

This partnership creates a comprehensive solution combining AI, system integration, and advanced sensing technology. It enhances accessibility and user engagement, offering scalable and versatile solutions across multiple environments.

Meta can also utilize Genius Holding's ultrasonic wireless motion detection technology to develop advanced body detection solutions for AR/VR environments, enhancing the immersive experience.

Fitness Market : Peloton (PTON)

- **Revenue:** 3.15 billion USD (2021), 2.19 billion USD (2022), 28 billion USD (2023).
- **Market Size:** 1.28 billion USD (Jul/2024)~50 billion USD (Jan/2021)
- **Registered users:** >6.4 million

Membership

- **All-Access:** For households with Peloton equipment (Bike, Bike+, or Tread). Unlimited access to a growing library of live streaming, on-demand classes, scenic rides, challenges, and real-time performance tracking. $44/M
- **App One:** Single-user membership on the Peloton web and/or iOS/Android App platform. No tracking performance metrics. $12.99/M.
- **App+:** App One + exercise bike, treadmill, and rower workouts. Single-user, $24/M

Value Proposition for Meta

Meta's social media platforms

- enhance user motivation and engagement.
- users can share progress, join challenges, and receive community support, which fosters a more engaging and motivating experience. This aligns with Meta's strengths in building and nurturing online communities.

Meta's AR/VR Integration:

- enabling advanced body detection, such as tracking lower body movements and interactions in multi-user environments.
- Meta/Ryban glasses & Quest could have advaced motion tracking with ultrasound

User Interaction and Data Collection:

- Utilizing the Llama AI in fitness scenarios allows Meta to gather diverse interaction data across various exercise contexts. This data can be instrumental in refining and expanding Llama's capabilities and features, promoting further development and innovation in open-source AI.

Transition to Rehabilitation Applications

- After establishing a solid foundation in fitness, the next phase involves exploring applications in rehabilitation, which require specialized medical knowledge.

Development Schedule

2024

- Jul: Finished the pilot app (please check our github) with generative AI for fitness
- Q3: collect responses for upgrade
- Q4: fitness club for demo sites at Taiwan.

2025

- Q1: lanuch fitness & exercise B2B services to multiple countries.
- Q2: lanuch fitness & exercise B2C products online
- Q3: Rehabilitation demo hospital at Taiwan
- Q4: Submit FDA De Novo/510k