Project Proposal:

Augmented Reality Beat Saber

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1 Motivation

VR rhythm titles such as *Beat Saber* motivate physical activity but are gated by cost, motion-sickness risk, and the need for a cleared play-space. Embedding the same "slice-the-beat" mechanic in augmented reality (AR) lets players see their real surroundings, lowering injury risk and nausea while making exergaming available on commodity mobile devices or pass-through headsets. Prior work shows (i) 10–50 min of *Beat Saber* is well-tolerated and elevates heart-rate / energy expenditure PMC, (ii) data-driven sword-swing recognition yields convincing interactions in VR combat the University of Bath's research portal, and (iii) mobile AR games can track bare-hand gestures in real time using optical flow and blob detection ResearchGate. *AR Saber* combines these insights to deliver an inexpensive, space-aware rhythm workout playable anywhere. Additionally, I would like to incorporate a physical foam sword to improve the realism of the game and marginally increased the amount of exercise being performed.

2 Related Work

Szpak et al. quantified after-effects of prolonged *Beat Saber* play and reported transient symptoms only PMC. Dehesa et al.'s "Touché" framework demonstrated accurate, low-latency classification of free-form sword trajectories using neural nets the University of Bath's research portal. Crisnapati et al. achieved 30 fps markerless hand tracking on Android via Lucas–Kanade optical flow fused with colour-blob segmentation ResearchGate. These studies inform our sensing pipeline, interaction design, and evaluation metrics. Though in my opinion they may be beyond my current ability to implement effectively, I will try to mimic their work in order to make a working project, but I may have to scale back a little bit.

3 Project Overview & Final Goals

AR Saber will spawn coloured "beat cubes" that stream toward the player in sync with music. The player slices them with either:

- **Mode A:** a lightweight plastic/foam baton + phone-mounted QR marker, tracked by the rear camera;
- **Mode B:** marker-less hand-pose estimation (MediaPipe Hands).

Core deliverables:

1. **Cross‑platform prototype** (Unity + ARFoundation) with one song, directional slicing, and score/accuracy feedback.
2. **Data‑driven gesture recogniser** fine‑tuned on 5 k labeled swings (transfer‑learned from "Touché" dataset).
3. **User study** (N = 10) measuring exertion (HR), flow, and AR comfort.

Success criterion: ≥ 90 % slice‑classification F1 score and System Usability Scale > 70.

4 Milestones & Timeline (Rest of the quarter)

Week	Milestone	Key Intermediate Deliverables
6	Gameplay Core Ready	- Beat-map loader + AR scene scaffold - Cubes spawning on-beat & basic collision box for a temp "blade"
7	Input & Tracking Integrated	Mode A: QR-baton tracking stable in-scene- Mode B: MediaPipe hand-pose pipeline running; raw slice events logged
8	Pilot Testing & Telemetry	- 3 pilot users finish one song - Capture swing F1, heart-rate, SUS quick-take- Compile bug/UX backlog
10	** polish ➜ Evaluate ➜ Report**	- Final build with refined FX/UI & color-blind palette - Draft & submit 2-page report + screenshots

References

[1] Szpak A., Michalski S. C., Loetscher T. *Exergaming With Beat Saber: An Investigation of Virtual Reality After-effects. J. Med. Internet Res.*, 22(10), 2020.

[2] Dehesa J. *et al. Touché: Data-Driven Interactive Sword Fighting in Virtual Reality.* Proc. CHI 2020.

[3] Crisnapati P. N. *et al.* "Real-Time Hand Palm Detection and Tracking AR Game Using Lucas–Kanade Optical Flow Combined with Color Blob Detection." *Proc. ICORIS 2019.*

Sutton

I’ve read your project proposal and the topic, scope, and timeline looks reasonable to me. Feel free to reach out anytime if you’d like to chat more about the project.

Just make sure that you have the resources to train and test your gesture recognition ML model and deployable on the headset. Do you have a fallback plan for the gesture recognition model? It’s better to have one baseline working solution so that at least you’ll have something to demo.

Best,
Brian