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触覚フィードバックを用いたヨガ体験の拡張に向けた基礎検討

A Preliminary Study on Vibralign: Enhancing Yoga Practice Through Haptic Feedback

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概要: 本研究では、触覚と聴覚を組み合わせた多感覚フィードバックにより、ヨガ実践の没入感と身体意識を高めることを目的とする。手首バンド型および床型の触覚提示インタフェース、ノイズキャンセリングヘッドホンを用いたシステムを構築し、11 名の被験者による比較実験を実施した。音声のみのセッションと比べ、触覚を加えたセッションでは、姿勢の認識や集中度が向上したと回答する傾向が見られた。また、振動の流れに方向性を感じたという報告もあり、触覚刺激が身体内部への注意を促す可能性が示唆された。

キーワード： ヨガ、身体性、触覚インタラクション

1. Introduction

Yoga is an ancient mind–body discipline rooted in Indian philosophy, with Hatha Yoga in particular emphasizing breath control (pranayama), body alignment, and the flow of internal energy as key components of practice[1]. The literature traces the evolution of yoga from its classical roots to contemporary forms, highlighting its embodied, sensory nature. Modern scholarship underscores the role of inner awareness,such as breath regulation, balance, and somatic grounding,in deepening both the physical and meditative aspects of yoga.

As contemporary yoga practice increasingly shifts to home and digital settings, new challenges emerge in preserving this embodied awareness without direct teacher guidance. In response, research in haptic interaction has explored the potential of tactile feedback to support alignment correction, breath pacing, and spatial orientation across fitness and rehabilitation contexts[2]. However, most prior systems rely on visual instruction or wearable devices, often reinforcing an externalized focus. Few have investigated screen-free, full-body feedback methods that prioritize internal sensation and energetic flow[3]. This gap motivates the present study, which integrates spatial haptics into home yoga to encourage deeper embodied engagement.

This study addresses key limitations in home-based yoga practice, where beginners often struggle with posture alignment, balance, and breathing rhythm due to the lack of embodied feedback. In the absence of in-person instruction, many rely heavily on screens or mirrors. While these visual tools offer structural cues, they often draw attention outward,away from somatic sensations and the subtle awareness central to yoga. This external focus can hinder the development of internal perception, making it difficult to sense grounding, alignment, and energetic flow.

To complement visual guidance and reduce over-reliance on it, we propose a multi-modal feedback system that in-

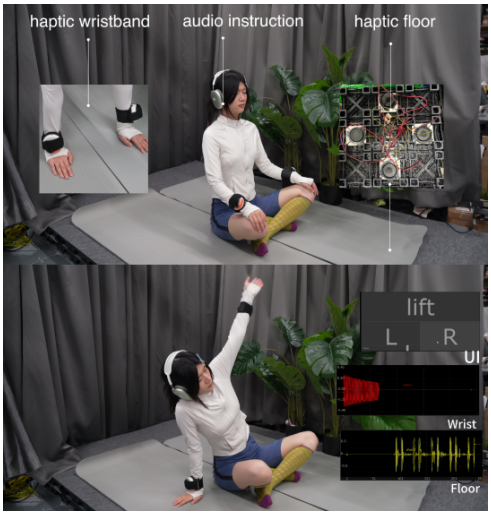

図 1: System Design & Software UI. e.g. When the user lifts their left arm, the “Lift-L” button will be pressed, triggering sequential vibration in the wristband and floor. The two waveforms indicate the vibration signals.

tegrates haptic and auditory cues to support inner body awareness. Rather than reacting to the user's movements in real time, the system delivers carefully timed signals that align with the general flow of a yoga sequence. These cues encourage users to shift their attention inward,following the rhythm of breath, weight transitions, and posture alignment,thus restoring the sensory and meditative depth of yoga practice.

2. Vibralign:Haptic Yoga System

2.1 Concept Design

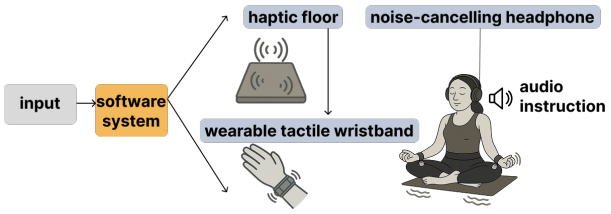

図 2: Concept Design

This study proposes a multi-sensory yoga feedback system designed to enhance inner body awareness through tactile and auditory cues. Instead of relying on visual correction, the system encourages practitioners to tune into the flow of energy and alignment within their bodies, supporting a more intuitive and meditative practice experience(Fig. 1). The design is grounded in the principles of Hatha Yoga, where breath, balance, and internal sensation are central to proper form and focus(Fig. 2).

The system, called Vibralign, consists of three core components: a haptic floor that provides ground haptic sensation[4], a wrist-mounted device that delivers directional vibration for posture guidance[5], and a noise-cancelling headphone to cancel noise effection. Together, these modules provide full-body feedback that maps movement and breath without interrupting the flow of practice. The concept aims to restore bodily presence in home-based yoga by shifting attention from screens to sensation.

2.2 System Architecture

The system delivers pre-programmed tactile cues through two key interfaces: a haptic floor and a wrist-mounted vibration device. During practice, the floor emits rhythmic pulses under the feet to signal grounding cues, helping users maintain balance and bodily awareness. At the same time, the wristband provides directional vibrations to gently guide users when the body is expected to shift or stabilize in specific poses.

All vibration patterns are pre-designed and triggered

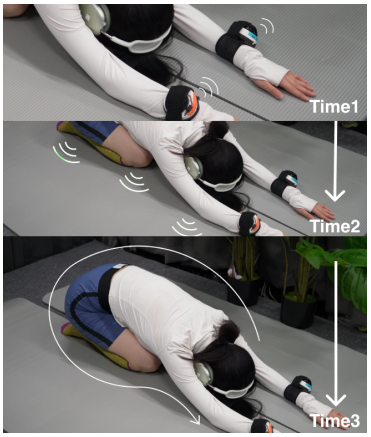

図 3: The wristband and the floor vibrate in sequence to create a full-body haptic flow.

in sequence through a custom interface built in TouchDesigner. Rather than sensing movement or breath, the system operates on a timed choreography aligned with common yoga flows(Fig. 3). This allows practitioners to focus inward, following the tactile rhythm as a substitute for visual instruction,supporting a screen-free, immersive practice experience.

2.3 Haptic Design for Yoga Postures

The haptic design follows the natural progression of a guided yoga flow, using rhythmic vibration patterns to signal movement direction, posture transitions, and breath timing. The tactile cues are carefully synchronized with the motion sequences of specific poses, such as Marjaryasana (Cat), Bitilasana (Cow), Sphinx Pose, and Child's Pose.

During spinal movements like Cat–Cow, rising motions are indicated by gradually intensifying vibrations, while downward or grounding phases are marked by tapering feedback. Circular arrows below represent the wristband's directional vibration, gently nudging the user into the intended movement pathway. In transitions such as from Sphinx to Child's Pose, the system uses a "haptic flow" to guide backward motion, followed by a stretch signal,represented by elongated, continuous pulses,encouraging the user to settle into the pose.

This design emphasizes spatial continuity and breath-movement integration, helping users align their body and attention with the energy flow of each sequence, without relying on visual instruction.

3. Preliminary Experiment

3.1 Experiment Design

We evaluated our system in a within-subjects user study with 11 participants (n=11). Participants were adults with varying levels of yoga experience (from beginners to

intermediate practitioners). Each participant attended two yoga sessions on separate days (to minimize fatigue): one session with Audio-Only guidance and another session with Audio + Haptics. The order of the conditions was counterbalanced – roughly half of the participants experienced the multisensory (audio+haptic) session first, and the others began with audio-only – to control for learning or ordering effects.

3.2 Procedure

For each session, participants followed a guided yoga routine approximately 10–15 minutes in length. The routine was the same for both conditions, consisting of a standard sequence of poses (e.g., mountain pose, forward fold, downward dog, warrior poses, etc.) and breathing instructions provided by the recorded audio instructor. Participants performed the session alone in a quiet room, wearing the noise-canceling headphones, through which the instructions and soft background music were played. In the multi-sensory condition, the haptic system was activated: as the participant performed the routine, the experimenter remotely triggered floor and wristband vibrations in sync with specific moments of the routine, as described in System Design. In the audio-only condition, no vibrations were delivered; participants only heard the same voice instructions and background music through the headphones. The participants were informed that different feedback modalities would be used in each session but were not given detailed specifics to keep their experience as natural as possible. Throughout the sessions, an experimenter observed for safety and to operate the haptic controls in the multi-sensory condition but did not intervene unless necessary. The pressure-sensitive mat also logged basic data, such as pressure distribution over time, to verify that participants performed the poses and to explore any differences in weight shift or stability between conditions, though these quantitative posture data are not the focus of this preliminary analysis.

3.3 Measures

After each session, participants filled out a questionnaire and participated in a brief interview. The questionnaire included subjective Likert-scale items and open-ended questions targeting the key outcomes of interest:

Posture awareness: e.g., "During the session, I was aware of my body's posture and alignment." Participants rated their agreement, and could elaborate on how aware or in-tune they felt with their body.

Immersion and focus: e.g., "I felt immersed in the yoga session and focused on my bodily sensations." This gauged presence and mindfulness.

Clarity of guidance: e.g., "The guidance was clear and easy to follow." To see if adding haptics affected how easy or hard the instructions were to follow.

Overall preference and experience: we asked which session they preferred and why, and how they would describe the multi-sensory feedback's effect on their experience.

In addition to verbal/written feedback, we employed a simple embodied visualization task during the interview for the multi-sensory condition. We gave participants a blank human silhouette diagram and asked them to draw the path or pattern of any vibration sensations they noticed. This was done to capture how they perceived the spatial aspect of the haptic feedback. For instance, did they feel the vibrations in a specific location only, or moving along the body, or radiating in some direction? These sketches, along with verbal descriptions, help illustrate participants' internal interpretation of the haptic cues, especially regarding the "flow" of vibrations from floor to wrist. All sessions were video recorded for reference, and the interview audio was recorded for qualitative analysis. We analyzed questionnaire ratings in comparing conditions and transcribed interview responses for thematic analysis focusing on the above categories: awareness, immersion, etc.. Given the small sample, statistical analysis was limited; our focus was on observing strong trends or preferences in this exploratory stage.

3.4 Results

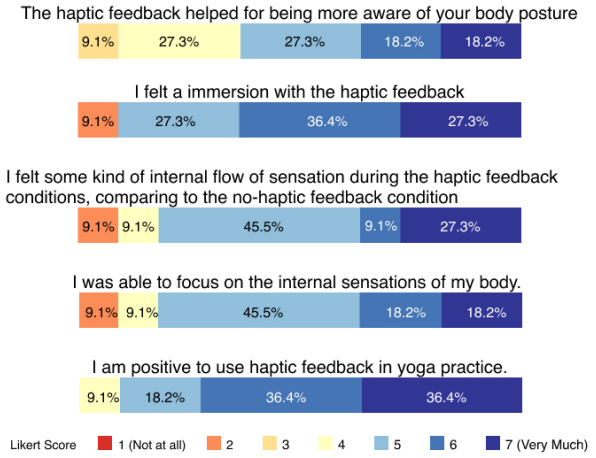

図 4: results from user test

The addition of floor and wristband haptic feedback had a clear positive impact on the yoga experience. Most participants reported enhanced posture awareness and deeper immersion during the multi-sensory (audio + haptic) session compared to audio-only. Vibrations helped draw attention to specific body parts, reinforcing verbal cues and supporting alignment(Fig. 4). Participants de-

scribed feeling more “in tune” with their bodies and more present during the practice, aided by the tactile input and noise-canceling headphones.

A notable finding was that 7 out of 11 participants perceived a directional flow in the vibration,from the floor to the wrist,describing it as “energy moving upward through the body.” Many spontaneously illustrated this sensation in post-session sketches, suggesting a cohesive embodied interpretation of the haptic sequence(Fig. 4).

In terms of overall preference, 10 out of 11 participants favored the multi-sensory session, citing greater engagement, clarity, and confidence in their posture. No participants found the vibrations distracting or unpleasant. Observations also suggested more immediate physical adjustments during haptic cues, indicating potential for real-time performance support.

4. Discussion

This preliminary study suggests that combining audio with tactile feedback from the floor and wrist can enhance the physical and sensory quality of yoga practice. Participants reported stronger awareness of posture, deeper immersion, and a greater sense of bodily connection. Even with simple manually triggered cues, many perceived a clear directional flow of vibration, from ground to wrist, which supported the sense of movement through the body.

The system was especially effective in drawing attention to specific body parts without relying on visual cues, which may benefit users practicing at home or with limited sensory access. The added tactile layer appeared to reduce distractions and helped users stay engaged and focused throughout the session. However, a few participants noted a brief adjustment period before getting used to the vibration.

Limitations include the small sample size and manual control of vibration, which may have introduced timing variation. The study focused on subjective experience; future work should explore whether the tactile feedback leads to measurable improvements in posture or balance using motion capture or instructor evaluations.

Future work include automating the feedback system using real-time pose detection, expanding haptic points beyond the wrist and floor, and testing different tactile patterns or modalities. Long-term use should also be studied to see whether continued exposure enhances learning or self-awareness. The system may also be adapted for specific populations, such as individuals with sensory impairments or attentional difficulties.

Future improvements may include customizable vibration sequences based on pose types or user preference, as well as more spatially differentiated feedback. While the current system avoids sensing for simplicity, integrating lightweight pose estimation could open new possibilities. Overall, the project highlights the potential of minimal, rhythm-based haptic guidance in supporting somatic engagement and screen-free interaction in home fitness.

5. Conclusion

This study explored how combining floor and wrist vibrations with audio can support posture awareness and immersion in yoga practice. In tests with 11 participants, the multi-sensory experience was widely preferred over audio alone. Users reported feeling more connected to their body, and many spontaneously described a sense of vibratory flow across the body. These early results highlight the potential of well-timed tactile feedback to enrich body-centered practices and suggest new directions for supporting focus and movement through touch.

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