Feelium: A Touchable Blimp Body for Aerial Telepresence

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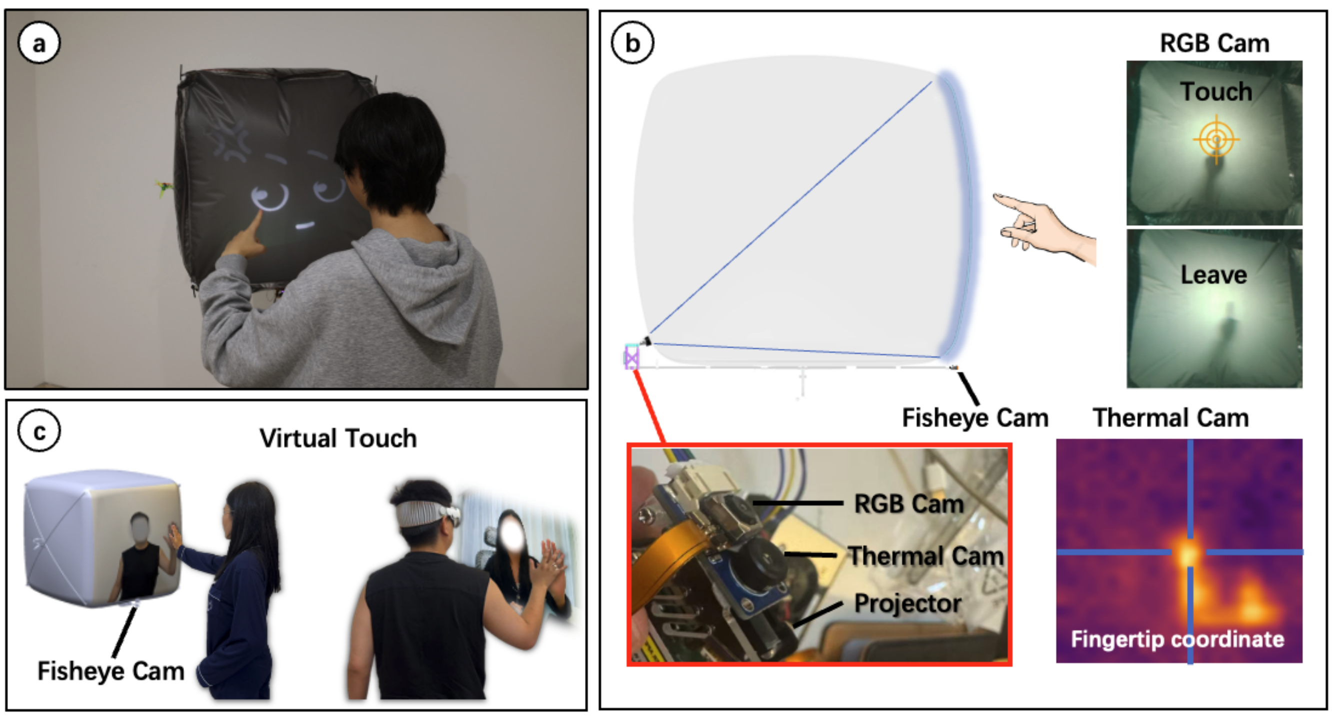

Figure 1: *Left:* the remote person inhabits the blimp through a VR headset and meets a partner's touch first-person. *Right:* two cameras split the roles: a front-facing fisheye camera gives the wearer wide-angle eyes, keeping a reaching hand in view until it lands, while a rear RGB camera (with a thermal companion) senses that touch as a shadow on the back-lit skin.

Abstract

Floating things invite touch. We present **Feelium**, a blimp-based telepresence platform that enables visual embodiment and touch interaction through its inflatable skin. Through a VR headset, a remote person inhabits the blimp, looking out of it first-person, appearing on its skin as a face or avatar, and steering it through

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the room. Partners in the room pat it, press a palm against it, draw on it, or lean into it; the skin senses each contact, renders it into the wearer's view in VR spaces.Touch thus provides a physical interaction channel for remote presence, turning the skin into a shared surface between remote and co-located partners.

CCS Concepts

• **Human-centered computing → Interaction devices**; *Virtual reality*.

Keywords

blimp, telepresence, touch, social touch, virtual reality

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1 Introduction

People reach out to touch what floats beside them: when Abtahi et al. wrapped a quadcopter in a safe-to-touch cage, touch leapt from 1.4% to 38.9% of interactions [3]. However, the system cannot pass the touch back to the person operating the drone. Later haptic and touchable drones kept the same limits: contact stays fingertip-scale and transient, sensing lives in external tracking systems, and the rotors stay loud and dangerous [1, 2, 5, 6, 10].

Blimps are the opposite. They can hover among people for hours and be touched without risk. Two decades of research have explored blimps as carriers and screens: tele-embodiment (PRoP [11]), projected faces [17], flying signage [16], light-field heads (LightBee [20]), ultrasound-positioned midair balloons [4], and flapping-wing companions built for closeness rather than input [18, 19]. Across these systems the envelope is output-only. Touchable inflatables do exist on the ground — hemispherical multi-touch displays [14], Emoballoon's unlocalized social touch [8], robot-reeled tangible balloons [12] — yet *none connects the touched surface to a remote person.* Touch, though, is precisely the channel that deepens mediated closeness, from remote handshakes [9] to cortisol-lowering huggable media and multi-task VR space [13, 15].

Feelium fills this gap: to our knowledge, it is the first to explore envelope touch in an aerial telepresence context. We contribute: (1) the Feelium system, which integrates a flying-display blimp platform, first-person VR inhabitation, and an onboard touch-sensing envelope; (2) a vocabulary of two-party touch interactions between a co-located partner and the remote person inside; and (3) a preliminary technical validation of touch sensing on an inflatable envelope.

2 The Feelium System

Blimp. Feelium's body is a 64 cm indoor helium blimp. Most of the envelope is blackened to retain helium and reject ambient light; the light-scattering front face is a rear-projection screen, lit from inside by a 24.9 g laser projector (Ultimems HD309) through a 180° fisheye lens. Four motors under closed-loop control hold a quiet, stable hover among people, and the complete body weighs 323.7 g against ~360 g of buoyant lift.

VR. A remote person puts on an Apple Vision Pro and *becomes* the blimp (Figure 1, left). A front-facing fisheye camera serves as the wearer's eyes; its wide field keeps a partner's reaching hand in view all the way to contact, so a touch arrives on screen rather than out of frame. The wearer's face or animated avatar is displayed on the envelope so partners see who is inside. Six motion commands (forward, backward, up, down, turn left, turn right) let the wearer drift, turn, and station the body in the room; control, video, and speech all travel over HTTP.

Touch. A press from outside casts a shadow in the projector's back-light. A second camera at the rear of the blimp (a Raspberry Pi AI Camera, Sony IMX500) watches the membrane from inside, paired with a 32×24 MLX90640-D55 thermal camera (Figure 1, right). The two split the roles cleanly: the RGB camera makes every touch decision, while the thermal camera senses only presence. The RGB shadow pipeline [7] keeps a slowly adapting reference image of the untouched, back-lit membrane and computes per-pixel *relative shadow depth*: the fraction of back-light lost against that reference, which makes the signal independent of the projector's uneven brightness. A shadow counts as touch when it passes either of two gates. An instant depth gate catches firm presses. A *sustained-anchoring* gate takes the rolling minimum of shadow depth over the past second: a pressing fingertip stays pinned to the membrane, while a hovering hand wobbles and its shadow momentarily thins. The fingertip is localized as the centroid of the shadow's darkening core. A tracker then segments the per-frame decisions into discrete events (onset to release, with debouncing), distinguishing *tap*, *hold*, and *swipe* by contact duration and fingertip path length. The thermal camera complements this. Each frame is differenced against a slowly adapting ambient baseline, and a cluster of pixels a few degrees above it reads as a warm body, letting the blimp notice a hand or partner drawing near before and between contacts. Thermal frames carry no touch decision (conducted heat through the membrane is too weak and slow). Each detected touch is rendered as a located marker in the wearer's first-person view, and the projector answers at the touched spot.

3 Interacting with an Inhabited Blimp

The skin's contact primitives, composed over time and area, turn everyday gestures into conversation between the partner in the room and the person inside. **Greeting pat**: taps on the "head" ripple into the wearer's view; the envelope returns a warm pulse. **Palm-to-palm**: the wearer raises a hand to meet a palm-shaped glow, two prints merging — held hands without hands. **Peck tap**: a tap at the "cheek" blooms a small heart; the wearer can pinch to send one back. **Finger-drawing guess**: strokes render live in the wearer's view, and a correct guess ignites the drawing. **Lean-in hug**: sustained large-area contact sets the whole skin glowing in a slow breathing rhythm. **Wearer-initiated**: a projected shimmer invites the partner's hand, and small motion replies (a drift closer, a gentle bounce) let the body respond. These exchanges suit settings where presence, not information, is the payload: a goodnight palm-press in a couple's daily call, a drawing game with a child before bed, or a distant relative drifting through a family gathering as a body people can pat hello.

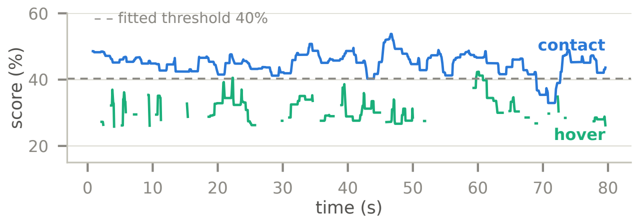

Figure 2: Sustained-anchoring score on labelled contact and hover clips: contact stays almost entirely above the fitted threshold; hover keeps dipping below.

4 Preliminary Results

We validated the skin on recordings from the real blimp (Figure 2): 228 labelled trials over three sessions — 138 prompted touches (78 taps, 24 holds, 36 swipes) and 90 negatives (30 hovers, 30 no-contact hand disturbances, 30 empty scenes) — plus three continuous ~75 s clips (steady contact, hovering, empty). *Detection:* the shadow detector is sensitive: with a hand present (touching or not), it registered activity in 171 of 198 trials, and it never fired in the 30 empty scenes. The hard decision is therefore not seeing the hand but *rejecting near-hovers*: thresholding the darkened area alone reaches 95% recall but only 77% precision, because a hand hovering just above the membrane darkens it almost as much as a touch. The sustained-anchoring gate closes this gap: on the continuous clips its score separates contact from hover at AUC 0.99, and a threshold fit on the first 60% of each clip holds 0.90 balanced accuracy on the unseen remainder. *Localization:* the 69 taps and holds with a detected landing point cluster tightly by prompted target (RMS spread 4–21 px, median 9 px in the detector's 640×480 working resolution); coordinates are camera-space, as screen-to-camera calibration is future work. The pipeline runs onboard at ~15 fps. Current limits: results are from dim-room lighting and one rectangular "sensitive skin patch" of the envelope.

5 Conclusion and Future Work

Feelium enables touchable, inhabitable aerial telepresence, integrating an onboard touch-sensing envelope with first-person VR embodiment for two-party social touch. A preliminary technical validation provided early evidence of the system's feasibility and potential, motivating a dyadic evaluation of social presence with the full touch loop as well as whole-envelope sensing, haptic feedback to the wearer, and gesture-piloted flight. Running fully onboard a quiet indoor blimp, this work hopes to give remote presence a body that invites touch, bringing separated partners and families within arm's reach.

Acknowledgments

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