Augmenting Eating Experiences through IoT-Based Eating Interventions
IoT を用いた摂食介入に基づく食体験拡張に関する研究

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内 容 梗 概（1ページ目に収めること）

In contemporary society, eating has increasingly been reduced to a mere act of nutrient intake, losing its multifaceted value including sensory richness and social significance. Against this backdrop, the field of Human-Food Interaction (HFI) has garnered attention for research on technologically augmenting eating experiences. However, most existing studies focus on pre-meal decision support and post-meal feedback, with limited intervention research during the “moment of eating” the during-meal phase. The during-meal phase represents the moment when multiple senses including taste, smell, and vision are integrated, constituting the stage where subjective eating experience undergoes its most significant transformation. To realize effective HFI in the during-meal phase, both fine-grained control of sensory stimuli—particularly smell—and real-time dietary guidance synchronized with eating behavior are indispensable, as they directly shape users’ multisensory experience and cognitive processing of food. To address this gap, this dissertation aims to clarify design guidelines for multimodal interventions during the eating phase and to systematically position, within the HFI framework, sensory presentation technologies that focus on taste augmentation and conversational agent technologies that focus on psychological satisfaction and dietary education support. Based on this perspective, it presents three complementary investigations. First, using Kaolid, our proposed lid-type olfactory device that controls scent delivery pathways during beverage consumption, we demonstrated the impact of presentation pathway differences between retronasal and orthonasal smell on taste augmentation, revealing that retronasal olfactory stimulation exhibits significantly superior sweetness enhancement effects compared to orthonasal smell. Furthermore, by presenting beverage colors that evoke the aroma, we confirmed that the synergistic effect of vision and olfaction further enhances changes in sweetness and taste perception, with participants reporting an average 24.2% increase in perceived sweetness when congruent visual cues were added to retronasal olfactory stimulation. Second, we developed PneuSpoon, a cutlery-integrated device that uses silicone balloons and features an aroma control system based on fluidic logic circuits for blending multiple scents. Subject experiments demonstrated taste augmentation through bite-level retronasal smell presentation synchronized with food consumption, achieving a 23.7% improvement in taste satisfaction and significant perceptual changes in flavor profiles. Third, we implemented the Co-Eating Agent, a multimodal dialogue system integrating voice, visual, and nonverbal behaviors, and demonstrated that psychological satisfaction and dietary knowledge acquisition can be mutually compatible during solitary eating. Cross-cultural experiments with Japanese and German participants (n=70) revealed that while multimodal presentation was effective universally, Japanese users rated overall satisfaction 16.6% higher than Germans and showed greater acceptance of avatar-based interaction, indicating cultural variations in embodied agent receptivity.