論 文 の 内 容 の 要 旨

論文題目 Phase-changing interfaces for human-material interaction
（ヒューマン・マテリアル・インタラクションに向けた相変化インタフェース）

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In the last half-century, the way we interact with digital information has diverged drastically. The history of human computer-interaction (HCI) started by interfaces based on mechanical switches, punch cards, or texts (also known as character user interfaces, CUIs), with which only specialized technicians could solve mathematical problems such as ballistic calculation of missiles. Then the personal use of the computer gradually became accessible to non-professional users, thanks to the invention of graphical user interfaces (GUIs) and intuitive hardware such as a mouse. After the touch interfaces became pervasive, more and more people started to interact with computers in more intuitive ways with smartphones.

From this tendency, I speculate that as the number of interfaces increases around our daily objects and environments, interaction techniques will become more physical rather than digital, and absolutely, materials can directly and intellectually interact with humans. I believe this direction

corresponds with the vision of ubiquitous computing, in which the interfaces weave themselves into our everyday life and disappear.

Standing on the idea of current shape-changing interfaces, I foresee the future where humans do not always interact with conventional computer interfaces, but also with the materials and objects around our living environment, via the physical properties of them, which I call as "human-material interaction (HMI)."

Especially, the research motivation of this thesis is to impart shape-changing interfaces the dynamic ability to leverage multiple "phases" of materials (i.e., solid, liquid, gas, and viscoelastic solid-liquid states), that is, two types of "phase-changing interfaces" as embodiment of human-material interaction in order to extend the current design space of interaction that is typically limited within a single phase of the material. The first project was Liquid Pouch Motors, the novel actuation mechanism using liquid-to-gas phase change of the low boiling point liquid. We investigated basic motion, mathematical analysis, fabrication method, mechanical evaluation, and four applications leveraging large expansion and actuation of phase change activated diverse heat source. The second project was Self-healing UI, the soft-bodied user interfaces made from self-healing materials that can restore mechanical and electrical integrity repeatedly just by making a physical connection. By tuning the rheological property of the self- healing materials, the interface device demonstrates unique properties of solid, solid-liquid, and liquid phases at the same time. We showed material preparation and device fabrication, as well as primitive sensing structures and design space with corresponding applications.

I believe human-material interaction and phase-changing interfaces proposed in this thesis will enrich and enlarge how we interact with our surrounding objects and environments in more diverse yet intuitive ways.