A Study of Air-based Interaction: Input and Haptic Feedback

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審 査 結 果 の 要 旨

１.論文の評価

Interaction technologies play an important role in Human-Computer Interaction (HCI) and have important connection with other fields. Conventional interaction devices, e.g. keyboard and mouse interfaces have limited options in providing engaging interaction to users. Thus, a large body of HCI work focuses on engaging alternative technologies, such as tangible interfaces and non-contact tactile interfaces.

Air is one underexploited medium that can engage users in interactions. Some recent studies have explored the use of air for user interfaces. However, little work has explored the use of air to provide input, multiple-channel output, and/or both input and output simultaneously through a single interface. Specifically, most of existing devices utilized compressed air and convert its energy into mechanical motion through pneumatic actuators. This method severely limits how air can be utilized to provide interaction between humans and computers, especially for input. This is because there was little exploration of the capabilities of air properties and limited resources that could facilitate the development of air-based interaction devices. Our work aims to leverage the use of air for novel interactions. We are the first to comprehensively explore and study the use of air for both input and output interaction, separately and simultaneously.

To increase the interaction bandwidth and choices regarding air-based interaction devices, this dissertation leverages the use of air properties to demonstrate the use of air as a category of interaction technology in three scenarios – Study 1: Multimodal interaction, Study 2: fMRI interaction, Study 3: Game interaction. The outcomes of this dissertation are: 1) an understanding of air properties for designing input interactions

and various modes of haptic feedback, 2) several new air-based interaction devices, 3) practical guidelines for interaction device design for multi-modal, MRI, and game interactions.

Through our work we are able to develop novel interaction devices. We have verified the benefits of air. We have also confirmed that air can be utilized to provide effective input and output which can dramatically enhance user engagement, expand new research and industrial opportunities and create new opportunities for research in sensitive fields where electrical fields and digital devices cause interference, such as the medical research.

In summary, this dissertation contributes to the field of interaction technologies by expanding possibilities and the interaction bandwidth of air-based interaction devices. The conclusion drawn and designs proposed will benefit future research not only in interaction technologies but also in brain science and game interaction. This work also has important implications for providing valuable user interfaces for better education, data visualization, medical/rehabilitation, and entertainment (game, virtual reality).

２.審査の経過と結果

（１）平成２８年７月６日　博士後期課程委員会で学位論文の受理を決定し、５名がその審査委員として指名された。

（２）平成２８年８月２４日　公開論文審査発表会及び最終試験を実施した。

（３）平成２８年９月５日　博士後期課程委員会で学位授与を可とし、教育研究審議会で承認された。