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論　文　内　容　の　要　旨

氏　名　（　馮 時　）	
論文題名	Designing Baby-Like Robots for Emotional Interaction with Older Adults (高齢者との感情的関わりのための赤ちゃん型ロボットの設計)

論文内容の要旨

In the society where older adults take up more percentages in the populations, elderly care becomes more important. With the realization of the importance of elderly care and the investment of more infrastructures for older people such as caring facilities, and equipment improves for the better experience for older people, problems still exist. Though therapy, exercise and medication develop fast to make sure of the physical health of older people, the mental care of them is still not well addressed. Behavioral and Psychological Symptoms of Dementia (BPSD) and loneliness are the main issues harming the mental health and even the physical health of older adults in the caring facilities. Furthermore, the lack of care staff makes the situation worse with even less people accompanying older adults, and more burdens on the existing care staff. With more older adults admitted in the caring facility, and their length of life becoming longer, the mental care of them needs to be addressed more. Among the methods of mental care, the use of socially assistive robots is a method drawing more attention and possibilities. Using robots in the caring process can solve mental care and the lack of labor at the same time. Within social assistive robots, baby-like robots are becoming increasingly relevant in this industry. Studies have shown that the image of an infant has the best acceptance among older adults, and the caregiving behaviors older adults would perform on the baby-like robots can activate their neuron activities to prevent dementia as well as reduce their sense of loneliness. Furthermore, the emotional interaction conducted by baby-like robots makes them special among other robots. Until now, many baby-like robots have been proven useful and effective in the mental care of older adults and have been used both in Japan and across the globe. However, there are still many about baby-like robots we do not understand and there can be more potential in baby-like robots to be discovered. Though baby-like robots showed usefulness, it is not understood what features in the design appealed to the older adults, and where in the older adult’s psychology was triggered during the interaction with baby-like robots. In this thesis, we use Hiro-chan as the representative of baby-like robots. We focus on the three aspects of design in Hiro-chan, which are the morphological design, the functional design and the purpose design, referring to the designs of infant features, emotional functions, and the pursuit of the purpose of Hiro-chan towards the group interaction. We built a model for the multimodal infant features in baby-like robots in the morphological infant design of baby-like robots, discovered the effects of different emotions of Hiro-chan on the older adults and finally modified the purpose of Hiro-chan into a mediator to facilitate communications between older adults. By conducting this study on baby-like robots, we were able to find theoretical evidence for the effectiveness of baby-like robots and saw the potential of building a society that contains human-centered human-robot interaction by using baby-like robots as a media. As an extension to this thesis, a more accurate model of the relationships between multimodal infant features, baby schema and caregiving behavior can be formed using different infant modals, and finally have the model quantified with more detailed alterations in the infant models. Furthermore, this study has the potential to be applied not only to older adults for its effects in emotional interaction, but also to other people with difficulties in cognitive interactions, thus discovering a new path of socialization and building of relationships through emotional interaction to cognitive interaction.

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論文審査の結果の要旨及び担当者

氏　名　（　馮 時　）		
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論文審査担当者	主 査　教 授 副 査　教 授 副 査　教 授	石黒　浩 吉川　雄一郎 岩井　大輔

論文審査の結果の要旨

本論文は、高齢化の進展に伴い顕在化するケア現場の人手不足、BPSD（認知症の行動・心理症状）、および孤独感といった課題に対して、社会的支援ロボット、とりわけ「赤ちゃん型ロボット」の有効性と設計原理を体系的に検討したものである。著者は代表例として「ひろちゃん」を対象に、(1) 形態的設計（マルチモーダルな乳児特徴表現）、(2) 機能的設計（情動表出・情動的な相互作用）、(3) 目的設計（人同士の社会的交流の媒介・促進）という三層からなる設計枠組みを提示し、各層が高齢者の養育行動、ロボットに対する印象、人同士の相互交流に及ぼす効果を一貫して検証している。

まず形態的設計について、baby schemaに関わるマルチモーダルな乳児特徴を統合する概念モデルを構築し、ロボットの外見・声の組み合わせが高齢者の養育的行動や受容性に与える影響を理論的に位置づけた。次に機能的設計では、ロボットの異なる情動表出が、対話相手である高齢者のロボットに対する印象や態度に影響を与える可能性を示した。さらに目的設計では、ひろちゃんを「癒やしの対象」にとどめず、集団コミュニケーションを促進する〈媒介者〉として位置づけ直し、施設環境における他者間交流を喚起・支援し得ることを示した。これらの検討は、理論モデルの提示と実証的検討を往還する構成により、赤ちゃん型ロボットの有効性に学術的根拠を与えている。

本論文の独自性は、赤ちゃん型ロボットの「何が」「どのように」高齢者に受容され、どの心理過程を介してケア行動や交流促進に結びつくのかを、形態・機能・目的の三層設計として統合的に記述した点にある。従来研究が有用性の事例的報告にとどまりがちであったのに対し、本研究はマルチモーダルな乳児特徴に誘発されるbaby schemaとケア行動の連関モデルを提示し、情動インタラクションの役割を理論化したうえで、人同士の交流の媒介という新たな運用目的を提案した点で実践的示唆も大きい。さらに、本枠組みは高齢者ケアに限らず、認知的相互作用に困難を抱える他集団への応用可能性を射程に入れており、情動的相互作用を基礎とした人間中心のヒューマン・ロボット・インタラクション設計に資する一般性を有する。

総じて、本論文は高齢者ケアにおける赤ちゃん型ロボットの理論的基盤と設計指針を精緻化し、情動から認知へと橋渡しする社会的相互作用の新たな在り方を提示した。今後、提示モデルの量的精緻化（特徴次元の定量化・効果量の推定・因果構造の検証）や、施設横断での実装評価を進めることで、学術的深化と社会実装の両面でさらなる発展が期待できる。以上より、本論文は博士（工学）の学位論文として十分に価値ある成果を示しており、学位授与に相応しいものと認める。