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研究課題名(和文) Empowerment loop: a value-based model of the interactive unity of human and technology

研究課題名(英文) Empowerment loop: a value-based model of the interactive unity of human and technology

研究代表者

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研究成果の概要(和文)：本プロジェクトでは、ヒューマン・マシン・インタラクションによるヒューマン・エージェントとヒューマン・エンパワーメントの支援の観点を調査した。まず、潜在的介護者へのステークホルダーインタビューから、AIやロボティクスを用いた先端技術は、介護者や被介護者を支援するものであれば、多くの介護シーンで評価されることがわかった。しかし、現状では、ほとんどのAI・ロボット系技術はこの要件を満たしておらず、日常の介護業務において大きな役割を担っていない。人間の主体性をさらに理解し、テクノロジーが人間の行動にどのように適合するように設計されているかを理解することが必要であることが判明した。

研究成果の学術的意義や社会的意義

This project showed that human-machine interaction is not the exclusive solution for resolving care-related issues. Only technology that meets the needs of caregivers and care recipients can become helpful in the future.

研究成果の概要(英文)：This project investigated the perspectives of human-machine interaction for assisting human agents and human empowerment. First, stakeholder interviews with potential caregivers showed that advanced technology using AI and robotics is appreciated in many care scenarios if the technology would support caregivers and care recipients. However, the current state of most AI/robotics-based technologies does not meet this requirement and does not play any significant role in daily care work.

It proved necessary to understand further human agency and how technology must be designed to fit human behavior. Based on an analysis of one of the few cases of a successfully implemented robotic rehabilitation system, a relational model was proposed for how to design human-machine interaction to support human empowerment. Most importantly, human needs and values must guide the entire development process.

研究分野：Philosophy

キーワード：assistive robotics human-robot interaction empowerment

1 . 研究開始当初の背景

To improve the quality of people's lives from multiple perspectives, including safety, convenience, and a sense of fulfillment, the Japanese government focuses on developing "Next generation robotics" and, more recently, "Society 5.0". The goal is to develop technologies that increase the degree of autonomy of human beings and enable them to live a more self-determined life (Hoof et al. (eds.) 2014). These technologies can be called empowerment technologies (ET). For this purpose, recent advances in AI- and robotic technologies are used to machines that incorporate into the human mind and body to supplement reduced functions (e.g., rehabilitation), support development (e.g., child care), or provide assistance and companionship (e.g., elderly care). The goal is to create an interactive unity of humans and technology. As a result, ET began to invade central domains of personal life and became a driving force for scientific and economic development. Therefore, political and social expectations are high regarding the future implementation of ET. However, with a few exceptions in rehabilitation, technologies to create interactive unities between humans and machines are still very limited and far from being produced on a commercial or industrial scale.

The fundamental methodological reason for the slow development process of ET is the disciplinary boundaries between engineering and philosophy/social sciences. The former lack models to handle subjective factors while the latter do not provide a sufficient formalization of subjective factors. Furthermore, there remains an implementation gap between R&D and social realities. On the one hand, social stakeholders raise expectations beyond the limits of the technological design of ET. On the other hand, rapidly evolving technologies such as ET elude value-based reflections also by their innovative force and run the risk of causing dependencies instead of providing empowerment.

2 . 研究の目的

To secure human empowerment in technological environments, a model is necessary that bridges the gap between naturalistic (scientific) methods and subjective approaches to human agency. Present approaches to human subjectivity are either reductive (philosophy of mind, cognitive science) or not compatible with technological design problems (phenomenology, hermeneutics).

To overcome this gap, this project focussed on the "Empowerment loop," a value-based model of the interactive unity of humans and technology. Considering the vulnerability of care-receiving humans and the complexity of (health)care scenarios in the design of ET, this model serves

1. to identify the norms and values for the social acceptance and the technological design of ET, and
2. to mediate diverging norms and values of social stakeholders and R&D (medical and engineering sciences).

3 . 研究の方法

The project followed a transdisciplinary method to establish a conceptual-empirical loop between philosophy, social stakeholders and R&D (cognitive and rehabilitation robotics). Initially, three phases were planned:

- (A) Norms and values of social stakeholders
 - (i) Defining the concept of the interactive unity
 - (ii) Assessing social stakeholder
 - (iii) Refining interactive unity
- (B) Norms and values of R&D
 - (i) Functional models of ET
 - (ii) Assessing R&D impact
 - (iii) Refining interactive unity
- (C) Implementation model of ET
 - (i) Defining implementation criteria
 - (ii) Assessing implementation
 - (iii) Finalizing interactive unity

In all phases, knowledge and expertise from philosophy, social sciences, robotics and AI were

used simultaneously. However, due to the Covid pandemic, fieldwork, the workshops, and other collaborative activities could only be implemented to a limited degree.

4 . 研究成果

Phase A

(i) To understand any human condition as a possibility for empowerment, health was defined as “the ability to adapt and self-manage”. Accordingly, ET in the healthcare context were defined as technologies for “supplementing reduced physical, sensory or cognitive functions”. These definitions set a new framework for conceptualizing human-machine relations from the perspective of human empowerment.

(ii) Together with collaborators from the social sciences, Japanese studies, and STS, interview guidelines for semi-structured interviews were developed, and 12 interviews were conducted with social stakeholders of medical care (nurses, physicians), rehabilitation, childcare, care for the elderly and disabled about their values and norms regarding the actual, future, or potential usage or non-usage of empowerment technologies. The analysis of all results and two detailed case studies about childcare and care of the disabled showed that the use of computer-/AI-/robotics-based technologies is basically appreciated. However, current technologies do often not meet the needs and values of the potential end-users. Considering their specific needs supporting technology must be developed in close interaction with the target groups.

(iii) Based on the initial definitions and the stakeholder assessment, the design principle of interactive unity for ET was redefined as the “asymmetric reciprocity of human and machine.”

Phase B

(i) Based on the successful implementation of a Japanese ET in the field of rehabilitation robotics (robotic rehabilitation system Hybrid Assistive Limb, HAL, Cyberdyne Inc.), the specifics of the engineering approach to Cybernics (University of Tsukuba) were established as a relational approach compared to the common individualistic approach to human-machine interaction. This relational view explains the systematic (functional characteristics of the Cybernics approach) and overcomes the cultural stereotypes related to Japanese robotics.

(ii) Based on two qualitative interviews, the scope of current AI/robotics regarding ET was assessed with the result that current technologies are still limited in terms of the formalization of subjective factors and therefore do not provide advanced human-machine interaction.

(iii) Design principles for the interactive unity of human and machine (functional model of empowerment technologies) were developed within a value-driven framework for advancing the interlocking of human values and computational modeling. This model shows how culturally sustainable social robotics can be designed as an ET (Fig. 1).

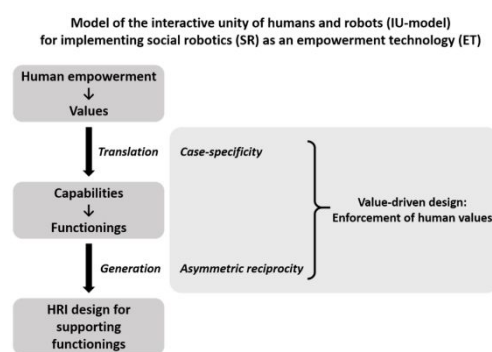


Fig. 1: Value-based design method for ET.

Phase C

(i) A critical review of the classical automation approach and more recent composite theories of human-machine networks showed that only a heterarchical interaction model of humans and machines could provide human empowerment.

(ii) Based on the interview data and further case studies, a humanistic concept of human-machine interaction was developed.

(iii) A heterarchical design model for the interactive unity of humans and machine was developed and exemplified by a case in rehabilitation robotics. (publication currently under review).

5. 主な発表論文等

〔雑誌論文〕 計4件（うち査読付論文 3件 / うち国際共著 3件 / うちオープンアクセス 1件）

1. 著者名 Patrick Grueneberg	4. 巻 51
2. 論文標題 支援ロボティクス(assistive robotics)の視点からみたエンパワメントとエンハンスメントとの関係について	5. 発行年 2021年
3. 雑誌名 体育哲学年報第	6. 最初と最後の頁 48-51
掲載論文のDOI (デジタルオブジェクト識別子) なし	査読の有無 無
オープンアクセス オープンアクセスとしている(また、その予定である)	国際共著 -
1. 著者名 Patrick Grueneberg	4. 巻 -
2. 論文標題 Culturally Sustainable Social Robotics as an Empowerment Technology	5. 発行年 2020年
3. 雑誌名 Culturally Sustainable Social Robotics. Proceedings of Robophilosophy 2020	6. 最初と最後の頁 127-138
掲載論文のDOI (デジタルオブジェクト識別子) 10.3233/FAIA200908	査読の有無 有
オープンアクセス オープンアクセスではない、又はオープンアクセスが困難	国際共著 該当する
1. 著者名 Patrick Grueneberg	4. 巻 -
2. 論文標題 Empowering patients in interactive unity with machines: Engineering the HAL (Hybrid Assistive Limb) robotic rehabilitation system	5. 発行年 2021年
3. 雑誌名 Humans and devices in medical contexts. Case studies from Japan	6. 最初と最後の頁 255-280
掲載論文のDOI (デジタルオブジェクト識別子) 10.1007/978-981-33-6280-10	査読の有無 有
オープンアクセス オープンアクセスではない、又はオープンアクセスが困難	国際共著 該当する
1. 著者名 Patrick Grueneberg	4. 巻 -
2. 論文標題 Institutionalizing the integration of patient and clinical needs in the design process of medical technologies	5. 発行年 2021年
3. 雑誌名 Mensch und Computer 2021 - Workshopband	6. 最初と最後の頁 1-2
掲載論文のDOI (デジタルオブジェクト識別子) 10.18420/muc2021-mci-ws06-238	査読の有無 有
オープンアクセス オープンアクセスではない、又はオープンアクセスが困難	国際共著 該当する

〔学会発表〕 計10件（うち招待講演 5件 / うち国際学会 8件）

1. 発表者名 Patrick Grueneberg
2. 発表標題 Empowerment technology - implementing norms and values of social stakeholders into models of human-machine interaction
3. 学会等名 VSFJ - German Association for Social Science Research on Japan: Annual Meeting of the Technology/STS Section (招待講演) (国際学会)
4. 発表年 2020年

1. 発表者名 Patrick Grueneberg
2. 発表標題 On the relationship between empowerment and enhancement from the viewpoint of assistive robotics
3. 学会等名 The 2020 Yokohama Sport Conference (招待講演) (国際学会)
4. 発表年 2020年

1. 発表者名 Patrick Grueneberg
2. 発表標題 Culturally sustainable social robotics as empowerment technology
3. 学会等名 Robophilosophy 2020 - Culturally Sustainable Social Robotics (招待講演) (国際学会)
4. 発表年 2020年

1. 発表者名 Patrick Grueneberg
2. 発表標題 Empowerment, enhancement and cyborgization: ethical implications of heterarchic human-machine relations in the robotic rehabilitation system HAL (Hybrid Assistive Limb)
3. 学会等名 STS Graz 2019 (国際学会)
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4. 発表年 2018年

1. 発表者名 Patrick Grueneberg
2. 発表標題 主観的エイジェンシー: 身体運動(歩行)の随意的開始
3. 学会等名 生涯学の挑戦 超高齢社会の中で最適に生きるために 「ックオフセミナー」
4. 発表年 2019年

1. 発表者名 Patrick Grueneberg
2. 発表標題 Methods for assessing voluntary initiation of gait movement: phenomenal analysis and physical measurements
3. 学会等名 生涯学の挑戦 超高齢社会の中で最適に生きるために 「国際シンポジウム」
4. 発表年 2019年

1. 発表者名 Patrick Grueneberg
2. 発表標題 Empowering Patients in Interactive Unity with Machines: Engineering the HAL (Hybrid Assistive Limb) Robotic Rehabilitation System
3. 学会等名 Panel AntSoc10 (EAJS 2021): Humans and Technology in Medical Contexts in Japan (国際学会)
4. 発表年 2021年

1. 発表者名 Patrick Grueneberg
2. 発表標題 Institutionalizing the integration of patient and clinical needs in the design process of medical technologies
3. 学会等名 Mensch und Computer 2021 (国際学会)
4. 発表年 2021年

1. 発表者名 Patrick Grueneberg
2. 発表標題 Voluntary initiation of forward gait and subjective efficacy - a transdisciplinary endeavor
3. 学会等名 VSFJ - German Association for Social Science Research on Japan: Annual Meeting of the Technology/STS Section (招待講演) (国際学会)
4. 発表年 2021年

〔図書〕 計0件

〔産業財産権〕

〔その他〕

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6. 研究組織

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研究協力者	ワグナー コジマ (Wagner Cosima)	ベルリン自由大学・University Library	
研究協力者	ブルックシュ ズザッネ (Brucksch Susanne)	ドイツ日本研究所	

6. 研究組織（つづき）

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研究協力者	涌井 智子 (Wakui Tomoko)	東京都健康長寿医療センター (82674)	

7. 科研費を使用して開催した国際研究集会

〔国際研究集会〕 計1件

国際研究集会 Norms and values of the usage of empowerment technologies	開催年 2019年～2019年
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8. 本研究に関連して実施した国際共同研究の実施状況

共同研究相手国	相手方研究機関