Social Imaging and Human Technology for Empowering People

Kenji Suzuki
University of Tsukuba
Tsukuba, Japan
kenji@ieee.org

ABSTRACT
Social imaging is regarded as a technology to identify and represent social behaviors. By using wearable devices and mixed reality technology, we aim at supporting people who have difficulty making facial expressions and interacting with other people, to express feelings and to act among people. In this paper, we introduce the overview of social imaging technologies and its application to empower people. We define the Social Imaging as the technology to identify and represent social behavior, and also define Human Technology as the technology for understanding and shaping behavior, which brings out latent human capabilities and potential abilities of people.

Author Keywords
Wearable Device, Affective Computing, Computational Behavioral Science, Autism Spectrum Disorders

ACM Classification Keywords
H.5.2 [User Interfaces]: User-centered design.

INTRODUCTION
We challenge to realize a future society where individuals with their own initiative will benefit from social interaction with others with the aid of technologies, which brings out latent human capabilities and potential abilities of people. The technology can support the understanding and shaping social behaviors and the assisted lifestyles will then become widely available.

The Social Imaging is defined as the technology to identify and represent social behavior. We consider that actions for interaction with other people according to one's own motivation and initiative are regarded as social behavior, and will establish a methodology to support the function and capabilities such as movement and functions of the mind and body, activities of daily lives, and social participation where people play a role at work, family and in the region, which are specified in the ICF (International Classification of Functioning, Disability and Health [1]). Sociality or social skill, which can be represented by understanding facial expressions, talking to someone eye-to-eye, understanding others' stances and feelings, cooperating with each other, expressing what you want to do, adjusting to the environment by reducing your own desire, is an important characteristic for people to live in harmony with others as well as intelligence and motor functions.

These technologies include: wearable technology to measure implicit and explicit social behavior, robotics technology that supports actions and modification through interactive feedback to sensory organs, biosignal processing technology that captures human intention and emotional response. We develop these technologies, called human technology, centered on advanced wearable technology that works with people to innovative science and technology fields for understanding and shaping behavior.

HUMAN TECHNOLOGY
One of the common global social challenges is the functional rehabilitation/regeneration of people who have difficulties and disabilities in movement. In addition to physically impaired persons, children with developmental disorders such as Autism Spectrum Disorder or Learning Disabilities are increasing around the world. Therefore, research on human-machine systems using robots and wearable devices in the field of medical care, nursing care, healthcare, medical treatment and education support, has been popular in recent years. Examples in the United States are Cyber-Human Systems (CHS) that aims to make a human-machine system where human and machines coordinate with each other. Also in Europe, in Horizon 2020, robot and ICT advancements made for societal implementation is an important issue and has a considerable amount of attention. These kinds of research on the innovation of human-machine systems (Shaping the human-technology frontier) is dramatically increasing importance around the world, and it is positioned as one of the six main strategic targets of NSF (National Science Foundation, US) along with data science, quantum mechanics, and astrophysics. Assistive technology is a term used for devices for people with disabilities, and it supplements the reduced physical and sensory functions. The assistive technology aims to allow people with disabilities to participate more fully in all aspects of life (home, school, and community) and increases their opportunities for education, social interactions, and potential for meaningful employment. On the other hand, the technology for human augmentation or enhancement have already become widely available. With the advancement of biomedical sciences and technologies progress, new ethical, legal and social implications should be considered.

SymCollab '18, March 11, Tokyo, Japan.

We develop four primary categories of abilities underlying the realization of social behavior (e.g., independent abilities) for the major outcome measures related to the movement and understanding for individuals with disabilities. The theoretical model is presented in Figure 1. There are typical impairment or disabilities as also shown in the Figure. These factors, in combination and alone, determine individuals with disabilities integration into society; an individual's type and severity of impairment. In the past, shaping behavior or training focused on the voluntary actions rather than the internal mechanism underlying social behavior. As mentioned before, difficulties of children with ASD or developmental disorders are regarded as the problems in the involuntary movement. We develop a methodology to let them notice the involuntary movement as the voluntary movement. The design methodology of these assistance for the deficits in sensory motor function may not suppress the cause but may lead the brain to find new solutions. This is a triggering or signaling based assistance for shaping behaviors. Involuntary movement are represented by the voluntary movement, and then they understand the behavior as the subjective experience.

Voluntary Movement: Action is the process of acting or doing something with his/her own intention. "Voluntary" here means that the human agent initiated the motion of her body based on her (spontaneous) decision and regardless whether there has been a previous external stimulus provoking a reflex or any internal constraint. The voluntary (active) approach to motor learning is more effective than a passive approach because the active approach entails activation of the entire processes related to the intended movement. It is also irrelevant whether motion actually occurs, concerning the release of a controlling neural signal (motor program) which may or may not result in bodily motion (ex. Paralysis). Therefore, persons with difficulty in the voluntary movement are mainly physically impaired. a disability that limits a person's physical capacity to move and coordinate actions although their intention is available.

Involuntary Movement: Persons with difficulty in the involuntary movement includes patients with neurodegenerative diseases, such as the tremor, chorea, or myoclonus by Alzheimer's disease, ALS or Parkinson's disease. In the framework of social behavior, we assume that persons with Autism Spectrum Disorder (Neurodevelopmental disorder) are main target group with special needs. One of the main characteristics of person with ASD is related to social problems that include difficulty communicating and interacting with others (DSM-5, Diagnostic and Statistical Manual of Mental Disorders) as well as restricted interests and repetitive behaviors [2]. We follow the approach that ASD starts as a movement disorder [3]). Children with ASD often exhibit clear movement developmental delays and disorganization, labeled and as clumsiness. The function of the brain is to organize movement, combined with attention to the feeling of self [4]. We consider that this is due to the ability to perceive

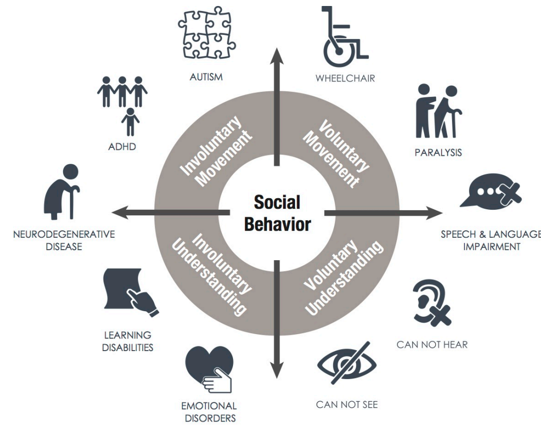

Figure 1. Human movement, cognitive characteristics and disabilities: Motion-perception / voluntary-involuntary axes

differences and then we need help their brain to perceive differences.

Voluntary Understanding: Actions speak louder than pictures when it comes to understanding what others are doing and feeling [5]. The representative ability of voluntary understanding is considered as awareness, which is the state or level of consciousness where sense data can be confirmed by an observer. Here we consider that it is regarded as the process to understand self and other's behaviors in a voluntary manner based on the subjective experience. However, current science, psychology, philosophy and neuroscience, has limited explanations for subjective experience. The mechanisms as well as influences of knowledge, attention, and intention on sensory awareness, including perceived timing of events are investigated in this field. This also include to assess the functions of information perceived without awareness in determining what is perceived with awareness.

Involuntary Understanding: In the previous researches on perception without awareness in cognitive psychology [6], stimuli are perceived even when observers are unaware of the stimuli. The involuntary cognitions in everyday life without a pre-determined focus is [7] Especially, an involuntary response to an unexpected and sudden stimulus is closely linked to affective processing [8]. Therefore, we focus on the emotion in this domain. In recent years, there has been an increased interest in detecting and supporting human physical and psychological wellbeing. A potential source of information can be the experiences of pleasure expressed though facial expressions, which can be used to infer a person's emotions and give insights into their internal state and happiness.

SOCIAL IMAGING

Social imaging is regarded as a technology to identify and represent social behaviors. By using wearable devices and mixed reality technology, we aim at supporting people who have difficulty making facial expressions and interacting

Figure 2. Devices and technologies related to Social Imaging: (a)(b) Wearable devices, (c) Mixed Reality based FUTUREGYM with a large scale floor projection system and (d) Paired Device

with other people, to express feelings and to act among people.

Technologies that visualize biological functions and behaviors that cannot be seen from the outside are called “imaging”. For example, “brain imaging” is regarded as the visualization of the functions of the brain, which reveals the structural and functional characteristics of each person’s brain. In recent years, several different sensing technologies have been developed about measurement and analysis of human behavior. In this domain, “behavior imaging” has been proposed in computational behavior science including the measurement of a personal viewpoint, which tries to understand each person’s behavior.

The uses of technology in interventions for children with autism have been widely reported (e.g., [9]). Previous studies have shown effectiveness of technology-based intervention for teaching academic skills [10] or social skills [11] [12]. Our emerging data highlights the effects of the technology use in measuring and promoting of positive social behaviors (emotion recognition, face-to-face, approaching to the peers, and touching with peers) in children with ASD.

In this study, we use several wearable devices in order to measure interactions as shown in Figure 2.; EnhancedTouch is a bracelet-type device to detect and enhance human-human physical touch [13]. Enhanced Reach is a bibs-type device to understand group dynamics and facilitate interaction [14]. Facelooks is a head-band type device to detect and enhance face-to-face behavior. FUTUREGYM is an interactive school gymnasium with a large-scale interactive floor projection system in a school setting in order to develop social interaction skills such as prosocial behaviors including helping and cooperating behaviors [15]. We design and implement an ergonomic wearable device, with high reliability, for reading positive expressions from facial EMG signals. The physical and physiological signals of the emotions such as smiles caused by these interactions [16][17]. New technologies to identify and represent social interactions are proposed as “social imaging.” The measured social behaviors are stored in a database as personal data, which includes physiological and behavioral characteristics.

There is a high demand in society for the establishment of an effective developmental support method for children with autism spectrum disorders (ASD). It is known that children with ASD have difficulty in social interactions involving understanding and using facial expressions. Therefore, support of social interaction at the early stage of children’s lives has drawn considerable attention in the field of child development. However, even though there have been several studies about motivations for facial expressions and communication towards people, it is difficult to carry out objective evaluations since it is not easy to make quantitative measurements in daily lives and at school. In order to understand these kinds of behaviors, it is indispensable to consider “social imaging”, whose aim is to understand people’s social behaviors.

DISCUSSION AND CONCLUSION

Our goal is to provide long-term support for children with special needs, who have social impairments, and to evaluate the effects of this support. Throughout long-term feasibility study, we have measured the smiles of children with ASD in a quantitative manner and have reported that their smiles might facilitate social positive behaviors [18]. We are going to develop an evidence-based developmental support system especially for shaping social behaviors of children with ASD. Deeper insight into their behavior, and elucidating the development of social interaction among people at the early stage of their lives, is very significant for learning social skills such as joint attention, imitation, language understanding, and understanding the development of communication skills. In this study, we aim to elucidate the environmental conditions in which children with ASD can demonstrate their abilities to the fullest, and to the establishment of an inclusive developmental support system, where we support forming creativity and sociality including cognitive functions and language functions.

Empathic design is an effective approach for paying attention to the user's feelings toward a solution in the practical site such as schools, after-school playroom or home. We need deep understanding of the existing environment, in particular, the unique goals and players of the organization. We need define the problem and potential areas of impact as well as the allocated resources and operational process. Then, we could align the current technology state to the target environment, and implement solutions into it together with players. Individuals with disabilities will be involved in each activity, as joint investigators of this project.

Helping children with developmental disorders (ASD, LD) to interact with their peers or caregivers with given visual aids. This helps these children to be aware of social cues, a behavior that is considered critical for the development of social interaction. Providing them with social signals by using visual or auditory feedback with wearable technologies. In addition, providing an automatic, objective measure of wellbeing could be used to support therapists, patients, engineers and doctors in order to improve therapeutic activities and devices, and also to understand spontaneous laughter and smiles. The developed wearable device for reading positive expressions are used. Based on the further investigations together with verbal information, providing quantitative measure of laughter and smiles recorded during long-term therapeutic interventions to quantify and infer the user's affective state in order to support psychological or medical professionals.

ACKNOWLEDGMENTS

This research was supported by JST-CREST, Japan (No. JPMJCR14E2). The authors would like to thank all colleagues, in particular, teachers and students of special needs school at Otsuka for the FUTUREGYM project.

REFERENCES

1. World Health Organization. 2001. *International Classication of Functioning, Disability and Health (ICF)*, Geneva, World Health Organization.
2. Dimitris Bolis, Leonhard Schilbach. 2017. Observing and Participating in Social Interactions: Action Perception and Action Control Across the Autistic Spectrum, *Dev Cogn Neurosci*, doi:10.1016/j.dcn.2017.01.009.
3. Victoria L. Chester, Matthew Calhoun 2012. Gait symmetry in children with autism, *Autism Research and Treatment*, ID:576478.
4. David Franklin, Daniel Wolpert. 2011. Computational mechanisms of sensorimotor control, *Neuron*, 72, 3 :425-442.
5. Charles Darwin. 1872. *The expression of the emotions in man and animals*, London, John Murray.
6. Philip M. Merikle, Daniel Smilek, John D. Eastwood. 2001. Perception without awareness: perspectives from cognitive psychology, *Cognition*, 79, 1-2: 115-134.
7. Julie Krans, June de Bree, Michelle L. Moulds. 2015. Involuntary Cognitions in Everyday Life: Exploration of Type, Quality, Content, and Function, *Front Psychiatry*, 6:7.
8. Peter J. Lang, Margaret M. Bradley, Bruce N. Cuthbert. 1990. Emotion, attention, and the startle reflex. *Psychol. Rev.*, 97: 377-395.
9. Joe McCleery. 2015. Comment on Technology-Based Intervention Research for Individuals on the Autism Spectrum, *J Autism Dev Disord*, 45, 12: 3832-5.
10. Victoria Knight, Bethany R. McKissick, Alicia Saunders. 2013. A review of technology-based interventions to teach academic skills to students with autism spectrum disorder, *J Autism Dev Disord*, 43, 11: 2628-48.
11. Florence D. DiGennaro Reed, Sarah R. Hyman, Jason M. Hirst. 2011. Applications of Technology to Teach Social Skills to Children with Autism, *Research in Autism Spectrum Disorders*, 5, 3: 1003-1010.
12. Anne M. Donnellan, David A. Hill, Martha R. Leary. 2012. Rethinking autism: implications of sensory and movement differences for understanding and support, *Front Integr Neurosci.*, 6:124.
13. Kenji Suzuki, Taku Hachisu, Kazuki Iida, 2016, EnhancedTouch: A Smart Bracelet for Enhancing Human-Human Physical Touch, In *Proceedings of SIGCHI Conference on Human Factors in Computing Systems* (CHI'16), 1282-1293.
14. Asaki Miura, Takashi Isezaki and Kenji Suzuki. 2013. Social Playware with an Enhanced Reach for Facilitating Group Interaction, In *Proceedings of CHI '13 Extended Abstracts on Human Factors in Computing Systems*, 1155-1160.
15. Issey Takahashi, Mika Oki, Baptiste Bourreau, Itaru Kitahara, Kenji Suzuki. 2017. FUTUREGYM: A gymnasium with interactive floor projection for children with special needs, *Int J Child Comput Interact*, (in press)
16. Anna Gruebler and Kenji Suzuki. 2014. Design of a Wearable Device for Reading Positive Expressions from Facial EMG Signals, *IEEE Trans Affect Comput*, 5, 3: 227-237.
17. Monica Perusquia-Hernandez, Masakazu Hirokawa, Kenji Suzuki. 2017. A Wearable Device for Fast and Subtle Spontaneous Smile Recognition, *IEEE Trans Affect Comput*, 8, 4: 522-533.
18. Atsushi Funahashi, Anna Gruebler, Takashi Aoki, Hideki Kadone and Kenji Suzuki. 2014. The Smiles of a Child with Autism Spectrum Disorder During an Animal-assisted Activity May Facilitate Social Positive Behaviors - Quantitative Analysis with Smile-detecting Interface, *J Autism Dev Disord*, 44, 3: 685-693.