# Exploring the Need of an Assistive Robot to Support Reading Process: A Pilot Study

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***Abstract*— Reading is one of the main activities that readers are immensely practicing during their daily lives and this activity is accompanied with some challenges that may cause disengagement during the process. Recently, assistive robotics technologies have shown extensive powerful effects in assisting its users to tackle various domain specific problems. From that perspective, the main goal of this pilot study is to investigate the problems that readers encounter during reading process. In addition, it aims to probe the need of an assistive robot that makes reading process less challenging. A questionnaire survey was distributed to 100 students at Universiti Utara Malaysia and the analysis of the results showed that an assistive robot is promising to support reading process. Similarly, this study detailed the embodiment and the design aspects that need to be applied while designing an assistive reading robot.**

***Keywords*— challenges in reading; preferences in robot; assistive robot; embodiment***

## I. INTRODUCTION

Rapid advancement in robotics technologies has drawn most of the researchers to search extensively various issues related to robotics technology. A large number of research projects are designed to develop assistive robots that can provide aids to its users and these kinds of assistance are ranged from physically support to socially support specific needs among humans (physically vs. socially contact) [1][2][3][4][5][6]. Recently, attention has been given for developing personal robots that can provide intelligent support during daily lives, such as PR (personal robot) to assist the transportation of active human life whereby the robot can carry baggage and automatically follow human [7], and kiosk type robot service that can help elderly people in managing their health condition[8].

Similarly, personal robots have been developed for helping many other aspects of lives such as weight management [9] and intelligent route navigation [10] . Nevertheless, in term of reading, there is a very limited data to explain clearly, what are the challenges that readers might face during reading process. These challenges can be explored and exploited with the support of robotics technology. For examples, the readers are obviously encountering some problems that hamper their reading process such as lack of focus and tiredness and the robotic technology can play an active part to reduce those problems. Moreover, there is scarcity in developing an assistive robot that can provide an aid during typical reading process. Therefore, the aim of conducting this pilot study is to acquire further information on what are the problems or challenges readers might encounter during reading process and to investigate whether readers prefer to have assistive reading robot or not in relation to their personality. In addition, this study has done to determine what design of assistive robot readers mostly like.

## II. RELATED WORKS IN READING AND ASSISTIVE ROBOTIC TECHNOLOGY

### *A. Reading*

People are usually practicing enormously large amounts of reading during their daily lives whether during their studies times or even for enjoyment. Reading is one of the most frequent activities of knowledge workers [11]. During reading, different types of media such as printed or electronic media are used. There are some evidences that showed many individuals may do not limit themselves solely to either print or electronic media but often use both [12], [13], [14]. In 2012, Clark reported in National Literacy Trust's annual survey detailed information about young people's reading where 21,000 young people participated and 50 per cent of them are enjoying reading materials related to them. The results also showed that 72.9 per cent of participants read paper-based materials, whereas 63.8 per cent read using computer and 21.1 per cent of the respondents read using other electronic devices. Therefore, reading is a frequent activity and it is an integral part of readers' lives.

Moreover, practicing reading is diverse, it based on the purpose of reading, and it is requiring different skills and strategies to achieve the goal of reading. Stoller [16] reviewed various purposes of reading, namely; 1) reading for general comprehension and pleasure, 2) reading for the gist, 3) reading to write and learn, 4) reading to search for specific information, and 5) reading to integrate information from multiple sources.

However, one notable obstacle during reading is disengagement, and thereby less willingness to continue

reading [17]. Therefore, knowing the main challenges that disengage readers from reading is the focus of this study in order to provide assistance with help of assistive robotics and to make reading process more interesting and meaningful.

*B. Assistive robotics*

The world of robotics technology has been existed long time ago and it developed dramatically from creating normal robots in giving small assistance in factories to more intelligence robots that can support humans in social manners during daily lives. The first concept of assistive robots (AR) were completely developed to assist humans with physical disabilities through physical interactions. These breeds of assistive robots were implemented in big range of environments such as school, home, and hospital [18]. All those robots were physically assisted and contacted with human such as rehabilitations robots [19][20], wheelchair robots [21] , educational robots [22], and manipulator arms for the physically disabilities [23]. With the increasing development in the field of human robot interaction, most of robotic developers are interested in designing and developing robots that can interact socially with human, which means new assistive robots will provide support to human through social interactions cues[24].

For example, Matarić [25] descried that socially assistive robots (SAR) is a new subfield of robotics that links together human-robot interaction, social robotics and service robotics. This concept also emphasized the main concern in SAR is to create machines capable of assisting user, typically in healthcare and education context, through social rather than physical interaction [25] . In addition, many socially assistive robots were developed to tackle various problems such as Autom to control loss weight [9], AIDA as a driving navigator [10], and Casper as a kitchen assistant for elderly [26]. Fig. 1 shows these examples respectively from left to right.

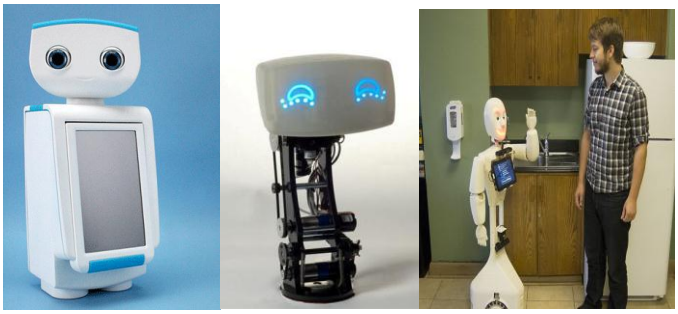

Fig. 1. Examples of Sociable Robots

In addition, one important issue that extremely related to SAR is the embodiment. Normally physical embodiment of robots has great effects in the design process of assistive robots, with the main goal in powering the interaction between users and robots [27]. Besides, Fasola and Mataric [28] have examined the embodiment of socially assistive robot in engaging elderly users with simple physical exercises. The researchers found that elderly users mostly prefer robot with physical embodiment over the virtual robot. The presence of embodiment is related to social presence, social interaction, enjoyment, and helpfulness of robot. Nonetheless, the embodiment of designing assistive robot to help readers during reading is yet to be investigated to determine what embodiment of robot (virtual/ physical) readers are most like in developing reading assistive robot. Therefore, this pilot study is also to seek the suit embodiment while designing an assistive reading robot.

## III. METHOD

A questionnaire survey was designed and disseminated to get descriptive analysis on various issues related to design a robot that can give an aid during reading process. The questionnaire was developed using 7-point likert-scale (1-Strongly Disagree, 2-Disagree, 3-Slightly Disagree, 4 Neutral, 5-Slightly Agree, 6-Agree and 7-Strongly Agree), multiple choice, and priority questions. Moreover, in order to measure the personality of respondents, an adopted survey concept was used as well [29]. A set of questionnaires was disseminated to 100 Universiti Utara Malaysia students and only 91 are returned. In return, a motivational gift was distributed for each participant. Moreover, convenience sampling was used to determine the targeted respondents based on [30] suggestion. Since most of the respondents are not familiar with robotics technology, enough information provided together with the survey as a reference. In addition, respondents' confidentiality was ensured by not taking their names, identities and other personal information.

The instruments were subjected to reliability and validity test where opinions of people who have good experiences have made in order to ensure the reliability and the validity of all instruments. In addition, some instruments such as challenges in reading, preferences in robot were tested with reliability and validity test. This study reliability analysis based on the Cronbach's alpha value, which is the representation of a lower level of internal consistency with its supposition of parallel measures. Based on [31], $\alpha \geq 0.7$ can be considered as a significant value that insures the instrument is reliable. The reliability analysis is presented in Table I.

TABLE I. RELIABILITY ANALYSIS

| Variable | Number of Item | Cronbach's alpha |
|---|---|---|
| **Preferences in robot** | 4 | 0.832 |
| **Challenges in reading** | 3 | 0.785 |

Similarly, the factor analysis was conducted to test how well the instrument measures the actual proposed measurement. It aims to ensure that the principle of validity and reliability of items are well achieved. This is also done through the analysis at loadings of each variable as depicted in Table II.

TABLE II. FACTOR ANALYSIS MEASUREMENT

| | Extraction Sums of Squared Loadings | | |
|---|---|---|---|
| **Variable** | Total | % of variance | Cumulative% |
| **Challenges in reading** | 2.108 | 70.257 | 70.257 |
| **Preferences in robot** | 2.656 | 66.400 | 66.400 |

Any constructs scored above 60 percent can be considered as valid for the measurement [32].

## IV. RESULTS AND DISCUSSION

Based on survey research method, 91 percent from overall questionnaires were returned (91 sets). The information about demographic of the respondents are summarized in Appendix I. All the returned questionnaires were statistically analyzed using SPSS 21 and Microsoft Excel. Generally, the survey questionnaire for this pilot study is started with questions related to reading and ended up with several questions regarding to designing an assistive robot that can provide an aid during reading. Regarding to reading, respondents have shown that they are usually applying different techniques during reading such as skimming (confirm the general idea of the text), scanning (seeking for specific piece of information), and close reading (paying very close attention / complete searching). Moreover, Fig. 2 shows the result of those techniques where 63.7 percent of respondents are applying scanning during reading. Meanwhile, 56 percent and 49.5 percent were the rate for close reading and skimming respectively.

From the results, it shown that respondents were facing challenges in reading (*mean*= 5.08, *std. deviation*=1.231) and at the same time preferring robot to assist reading was promising (*mean*=4.79, *std. deviation*=1.166). Table III summarizes the details of information for each item pertinent to challenges in reading and preferences in robot. This also includes the main challenges that readers might encounter while reading, such as fatigue, mental exhaustion and distraction. It provides a clear idea to show why personal reading robot (assistive robot) is needed. Besides, the interesting thing is readers prefer a personal robot to assist them while reading regardless their personality. This finding was confirmed through no significant correlation has been identified between personality and preferences in robot. In addition, a positive correlation has been identified between digital reading and preferring assistive robot (r=0.28, p= 0.08). It means readers who are using digital medium for reading also agree to have a robot to assist them as well.

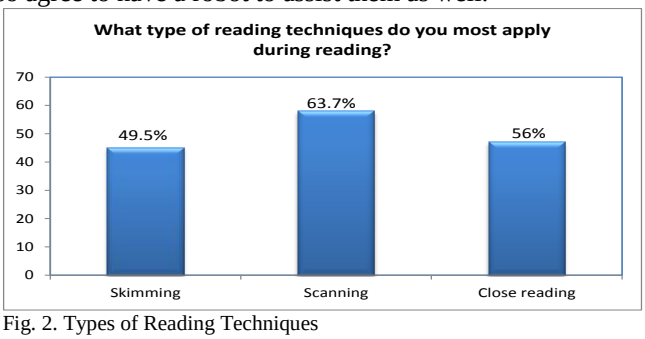


Fig. 2. Types of Reading Techniques

TABLE III. CHALLENGES AND PREFERENCES ITEMS

| **Challenges in reading** | | |
|---|---|---|
| ***Items*** | ***Mean*** | ***Std. Deviation*** |
| It's easy for me to get distracted/ lose concentration during reading process | 4.44 | 1.522 |
| Reading for a very long duration causes me fatigue such as eye strain and backache | 5.47 | 1.377 |
| Reading for a very long duration causes me mental exhaustion such as lack of focus and tiredness | 5.34 | 1.515 |
| **Preferences in robot** | | |
| ***Items*** | ***Mean*** | ***Std. Deviation*** |
| I like the idea of having a personal robot that can support my reading process | 5.10 | 1.484 |
| Personal robot can encourage/motivate me during reading | 4.51 | 1.493 |
| Personal robot can help me to reduce my fatigue such as backache and eye strain during reading | 4.82 | 1.371 |
| Personal robot can help me to reduce my mental exhaustion such lack of focus and tiredness during reading | 4.77 | 1.367 |

In addition, reasons that cause loss of concentration during reading are various. Based on this pilot study results, the main reason is tiredness where 68.10 percent of respondents are losing concentration during reading when they get tired. Drowsiness scores the lowest effect on concentration. The percentage of other reasons like hungry, bored, and difficult to understand are almost identical to each other as indicated 53.80%, 57.10%, and 56% respectively. Fig. 3 presents all factors that cause loss of concentration during reading.

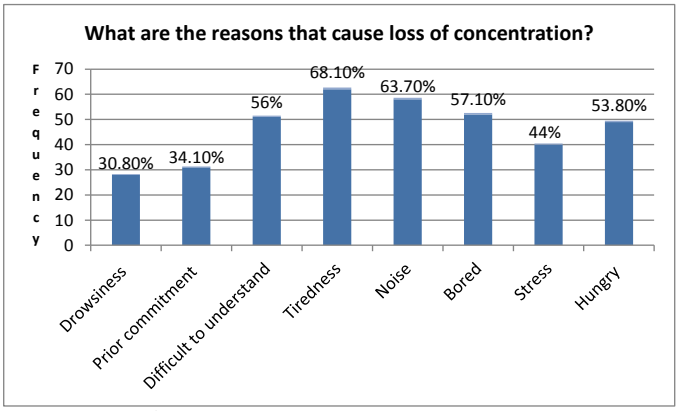


Fig. 3. Reasons of Losing Concentration

In regards to design a personal robot, experiences of respondents with personal robots was evaluated as well. The results shown very high percentage of respondents (90.1%) has no experiences with personal robots. Fig. 4 depicts the different percentages of having experiences with personal robot.

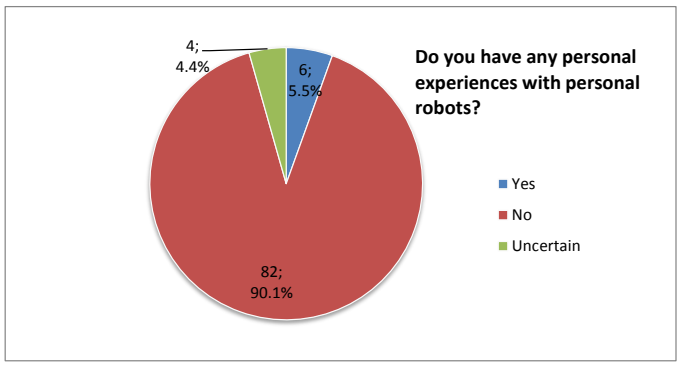


Fig. 4. Percentages of Experiences with Personal robot

Despite of very high percentage of respondents who have no experiences with personal robots, more than half of them (56 percent) have good image about personal robots. They perceived "personal robot is good in helping human", while a small number of respondents (3.30 percent) have bad image about personal robots. Fig. 5 illustrates the image that respondents have about personal robots.

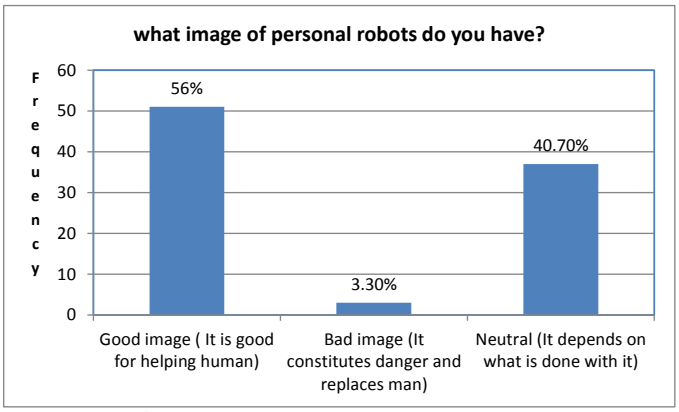


Fig. 5. Images of having a Personal Robot

Similarly, the embodiment aspect of a personal robot is also evaluated in this pilot study. This study revealed that physical embodiment was the highest choice as indicated with 41 percent of respondents prefer a personal robot to be designed as a physical entity. Conversely, a virtual embodiment of personal robot received only 23 percent vote from the respondents. Fig. 6 displays respondents' preferences related to the design of a personal robot.

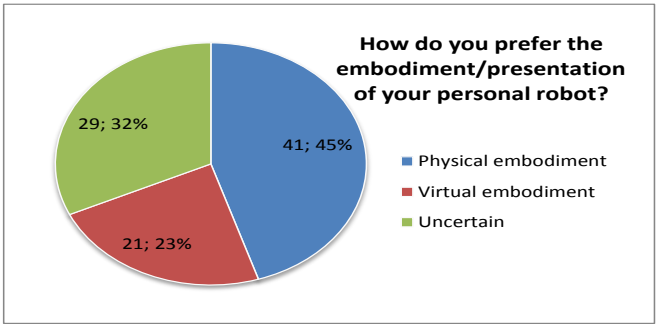


Fig. 6. Embodiment of Personal Robot

This pilot study also revealed the most suitable object that can be represented as an assistive robot to support readers during reading. Five different objects (table lamp, table fan, clock, penholder, and cup/mug) were presented as depicted in Fig. 7. Respondents were asked to choose their priority on the objects as regards their preferences in designing an assistive reading robot. The results showed that respondents generally favored table lamp as first choice to be represented as an assistive reading robot (*mean* 4.26 and *std. deviation* 0.828). Table fan was the second favored object (*mean* 3.37 and *std. deviation* 1.151) and followed by clock (*mean* 3.29 and *std. deviation* 1.293). Penholder was chosen as forth choice (*mean* 3.26 and std. *deviation* 1.143). While cup/mug was made as the last choice to be presented as an assistive reading robot (*mean* 3.03 and *std. deviation* 1.143)

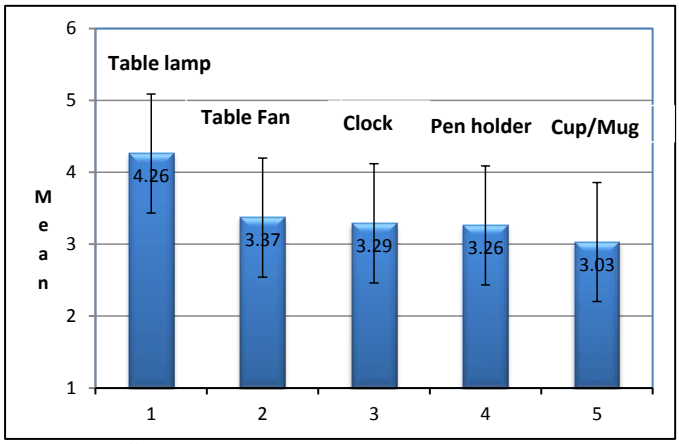


Fig. 7. Five different Objects represented as assistive Robot

Related to the functions, respondents wished the robot to assist them during reading and it was discovered that majority of them are pleased to have an assistive robot to motivate them. This is supported with the rating of 83.5 percent. About 78 percent of the respondents want the *robot to control the intensity of light* for them, while those *want short conversation* from robot were ranked third with 75.8 percent. Whereas 73.6 percent of the respondents want *reminders from robot* (e.g. remind them to take a break), 56 percent decided a robot can help them to play their favourite music. Fig. 8 presents the functionality that a personal robot should do to assist readers.

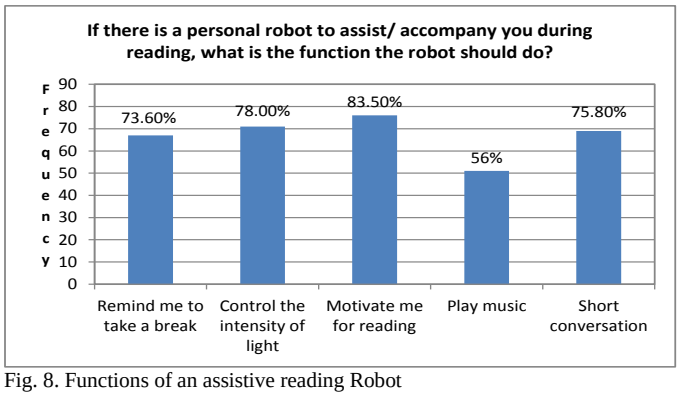


Fig. 8. Functions of an assistive reading Robot

For the next item, respondents prefer the robot to have some qualities such as *intelligence* (the capacity for knowing your needs), *empathy* (the capacity for recognizing your feeling), *rationality* (the capacity for reasoning and respond logically towards you), and *reliability* (the capacity of robot to be trusted by you). From these constructs, it shows that 89 percent of the respondents prefer the robot to be intelligence whereas 71.4 percent prefer robot to be rational. This pilot study results also indicated that 67 percent and 69.2 percent of the respondents prefer the robot to be empathy and reliable respectively. This can be seen in fig. 9.

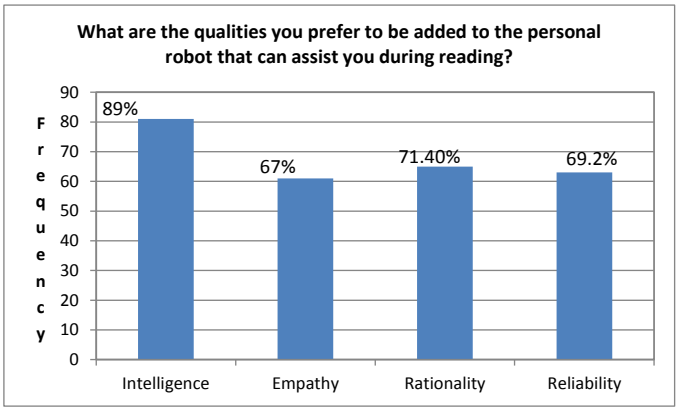

Fig. 9. Equalities in personal Robot

Overall, this pilot study has generally shown that reading process is an important activity where readers disengage from reading due to some problems. It also can be concluded that robotics technology has a promising effect to assist reading process.

## V. CONCLUSION AND FUTURE WORK

This pilot study has provided good fundamentals concepts related to the problems that readers encounter during reading process. Using a convenience sampling approach and survey questionnaire, it helps researchers to solidify the idea to design an assistive robot to help readers. The survey has confirmed that readers encounter some challenges when reading, such as fatigue, mental exhaustion, and distractions while reading. The readers prefer a table lamp to be represented as a personal robot to support reading. Therefore, in order to develop a reading assistive robot, it is necessary to incorporate all the identified results such as physical embodiment and specific qualities such as intelligence, empathy, and reliability as a design principle. This on-going study aims design a personal robotic lamp as a companion robot in order to make reading processes more interesting for readers.

## REFEERENCES


[1] R. Pérula-Martínez, J. García-Haro, C. Balaguer, and M. Salichs, "Developing Educational Printable Robots to Motivate University Students Using Open Source Technologies," *J. Intell. Robot. Syst.*, pp. 1–15, 2015.

[2] R. Pandhi and S. Khurana, "Assistive Feeding Device for Physically Handicapped Using Feedback Control," in *Robot Motion and Control 2007 SE - 32*, vol. 360, K. Kozłowski, Ed. Springer London, 2007, pp. 351–359.

[3] I. Verner, D. Cuperman, A. Cuperman, D. Ahlgren, S. Petkovsek, V. Burca, B. Poudel, and J. Santoso, "Humanoids at the Assistive Robot Competition RoboWaiter 2012," in *Robot Intelligence Technology and Applications 2012 SE - 73*, vol. 208, J.-H. Kim, E. T. Matson, H. Myung, and P. Xu, Eds. Springer Berlin Heidelberg, 2013, pp. 763–774.

[4] E. Torta, F. Werner, D. Johnson, J. Juola, R. Cuijpers, M. Bazzani, J. Oberzaucher, J. Lemberger, H. Lewy, and J. Bregman, "Evaluation of a Small Socially-Assistive Humanoid Robot in Intelligent Homes for the Care of the Elderly," *J. Intell. Robot. Syst.*, vol. 76, no. 1, pp. 57–71, 2014.

[5] J. Fasola and M. Matarić, "Socially Assistive Robot Exercise Coach: Motivating Older Adults to Engage in Physical Exercise," in *Experimental Robotics SE - 32*, vol. 88, J. P. Desai, G. Dudek, O. Khatib, and V. Kumar, Eds. Springer International Publishing, 2013, pp. 463–479.

[6] M. Mahyuddin and G. Herrmann, "Cooperative Robot Manipulator Control with Human 'pinning' for Robot Assistive Task Execution," in *Social Robotics SE - 52*, vol. 8239, G. Herrmann, M. Pearson, A. Lenz, P. Bremner, A. Spiers, and U. Leonards, Eds. Springer International Publishing, 2013, pp. 521–530.

[7] N. Hirose, R. Tajima, and K. Sukigara, "Personal robot assisting transportation to support active human life—Human-following method based on model predictive control for adjacency without collision," 2015, pp. 76–81.

[8] H. Ahn, I.-H. Kuo, C. Datta, R. Stafford, N. Kerse, K. Peri, E. Broadbent, and B. MacDonald, "Design of a Kiosk Type Healthcare Robot System for Older People in Private and Public Places," in *Simulation, Modeling, and Programming for Autonomous Robots SE - 49*, vol. 8810, D. Brugali, J. Broenink, T. Kroeger, and B. MacDonald, Eds. Springer International Publishing, 2014, pp. 578–589.

[9] C. D. Kidd and C. Breazeal, "Robots at home: Understanding long-term human-robot interaction," in *2008 IEEE/RSJ International Conference on Intelligent Robots and Systems*, 2008, pp. 3230–3235.

[10] K. Williams, J. A. Flores, and J. Peters, "Affective Robot Influence on Driver Adherence to Safety, Cognitive Load Reduction and Sociability," in *Proceedings of the 6th International Conference on Automotive User Interfaces and Interactive Vehicular Applications*, 2014, pp. 1–8.

[11] G. Buscher, A. Dengel, R. Biedert, and L. V Elst, "Attentive documents: Eye tracking as implicit feedback for information retrieval and beyond," *ACM Trans. Interact. Intell. Syst.*, vol. 1, no. 2, p. 9, 2012.

[12] W. A. Shelburne, "E-book usage in an academic library: User attitudes and behaviors," *Libr. Collect. Acquis. Tech. Serv.*, vol. 33, no. 2–3, pp. 59–72, 2009.

[13] N. M. Foasberg, "Student reading practices in print and electronic media," *Coll. Res. Libr.*, vol. 75, no. 5, pp. 705–723, 2014.

[14] N. M. Foasberg, "Adoption of e-book readers among college students: A survey," *Inf. Technol. Libr.*, vol. 30, no. 3, 2011.

[15] C. Clark, "Children's and young people's reading today," *Find. from 2011 Natl. Lit. Trust Annu. Surv.*, 2012.

[16] F. L. Stoller, "Viewing extensive reading from different vantage points," *Read. a Foreign Lang.*, vol. 27, no. 1, p. 1, 2015.

[17] S. Kalyuga, "Cognitive Load Theory: Implications for Affective Computing.," in *In proceeding of the Twenty-fourth International Florida Artificial Intelligence Research society Conference*, 2011.

[18] D. Feil-Seifer and M. J. Mataric, "Defining socially assistive robotics," in *In Proceedings of the 2005 IEEE 9th International Conference on Rehabilitation Robotics*, 2005, pp. 465–468.

[19] R. M. Mahoney, H. F. Van Der Loos, P. S. Lum, and C. Burgar, "Robotic stroke therapy assistant," *Robotica*, vol. 21, no. 01, pp. 33–44, 2003.

[20] S. Dubowsky, F. Genot, S. Godding, H. Kozono, A. Skwersky, H. Yu, and L. S. Yu, "PAMM-a robotic aid to the elderly for mobility assistance and monitoring: a 'helping-hand' for the elderly," in *In Proceedings of IEEE International Conference on Robotics and Automation*, 2000, vol. 1, pp. 570–576.

[21] J. Glover, "A robotically-augmented walker for older adults," *Tech. report,Computer Sci. Dep. Carnegie Mellon Univ.*, 2003.

[22] T. Kanda, T. Hirano, D. Eaton, and H. Ishiguro, "Person identification and interaction of social robots by using wireless tags," in *In Proceedings IEEE/RSJ International Conference on Intelligent Robots and Systems*, 2003, vol. 2, pp. 1657–1664.

[23] A. Giménez, C. Balaguer, A. M. Sabatini, and V. Genovese, "The MATS robotic system to assist disabled people in their home environments," in *In Proceedings of 2003 IEEE/RSJ International Conference on Intelligent Robots and Systems*, 2003, vol. 3, pp. 2612–2617.

[24] D. Feil-Seifer and M. J. Mataric, "Socially assistive robotics," *Robot. Autom. Mag. IEEE*, vol. 18, no. 1, pp. 24–31, 2011.

[25] M. Matarić, "Socially assistive robotics: human-robot interaction methods for creating robots that care," in *Proceedings of the 2014 ACM/IEEE international conference on Human-robot interaction*, 2014, p. 333.

[26] P. Bovbel and G. Nejat, "Casper: An Assistive Kitchen Robot to Promote Aging in Place," *J. Med. Device.*, vol. 8, no. 3, p. 30945, 2014.

[27] C. D. Kidd, "Human-robot interaction: Recent experiments and future work," in *Invited paper and talk at the University of Pennsylvania Department of Communications Digital Media Conference*, 2003, pp. 165–172.

[28] J. Fasola and M. Mataric, "Comparing physical and virtual embodiment in a socially assistive robot exercise coach for the elderly," *Cent. Robot. Embed. Syst. Los …*, 2011.

[29] O. P. John and S. Srivastava, "The Big Five trait taxonomy: History, measurement, and theoretical perspectives," *Handb. Personal. Theory Res.*, vol. 2, no. 1999, pp. 102–138, 1999.

[30] J. Ritchie, J. Lewis, C. M. Nicholls, and R. Ormston, *Qualitative research practice: A guide for social science students and researchers*. Sage, 2013.

[31] StataCorp, *stata multivariate statistics reference manual*. Texas: Stata Press, 2013.

[32] and E. A. F. Hair, F. Joseph, C. William J. Black, J. Barry, J. Babin, E. Rolph, *Multivariate Data Analysis*. Englewood Cliffs, NJ: Prentice Hall, 2010.

# APPENDIX I

## OVERVIEW OF DEMOGRAPHIC INFORMATION

| | Frequency | Valid % |
|---|---|---|
| **Respondent's Gender** | | |
| Male | 44 | 48.4 |
| Female | 47 | 51.6 |
| Total | 91 | 100.0 |
| **Respondent's Age** | | |
| 15 – 20 | 4 | 4.4 |
| 21- 30 | 69 | 75.8 |
| 31- 40 | 11 | 12.1 |
| > 40 | 7 | 7.7 |
| Total | 91 | 100.0 |
| **Respondent's Living situation** | | |
| Living alone | 17 | 18.7 |
| Living with housemate | 2 | 2.2 |
| Living with spouse | 7 | 7.7 |
| Living with children | 2 | 2.2 |
| Living with roommate | 57 | 62.6 |
| Living with other relatives | 6 | 6.6 |
| Total | 91 | 100.0 |
| **Respondent's Monthly income** | | |
| < 1000 | 53 | 58.2 |
| 1000 -2000 | 16 | 17.6 |
| 2001- 3000 | 15 | 16.5 |
| 3001- 4000 | 3 | 3.3 |
| > 4000 | 4 | 4.4 |
| Total | 91 | 100.0 |
| **Respondent's level of education** | | |
| Ph.D. | 10 | 11.0 |
| Master | 39 | 42.9 |
| Diploma | 1 | 1.1 |
| Undergraduate/ degree | 33 | 36.3 |
| Matriculation/STPM/A level | 8 | 8.8 |
| Total | 91 | 100.0 |
| **Respondent's Nationality** | | |
| Malaysian | 62 | 68.1 |
| Non- Malaysian | 29 | 31.9 |
| Total | 91 | 100.0 |