On New Research Guidelines for the Deployment of Socially Assistive Robots for Elder Care Amidst the COVID-19 Pandemic

Caio Mucchiani[1], Pamela Cacchione[1], Ross Mead[2], Michelle J. Johnson[1] and Mark Yim[1]

***Abstract*— This work initially proposed the deployment of a socially-assistive robot (SAR) in low-income elder care facilities based on the findings of prior studies, considering relevant tasks to meet the needs of all stakeholders (clinicians, caregivers and older adults) to be performed by the robot. This study was combined with the investigation of low-cost modular hardware and software. Although the need for further testing of a low-cost mobile platform capable of human-robot-interaction (HRI) in elder care settings remains, the current global COVID-19 pandemic and its extreme effects on older adults (especially in nursing homes and PACE centers) led to a pivot in our research question. We are combining this assistive technology and its use in aiding the wellness screening for COVID-19 symptoms in older adults in these settings. In lieu of the robot actively and physically interacting with users considering previous ranked tasks, a series of scenarios based on current procedures adopted by clinicians in screening older adults will be considered. A comparison study will investigate older adults' preference in having robot or human screening and monitoring for COVID symptoms by actively checking vital signs or through engaging in dialog and verbal instructions for preventive purposes. Post-interaction surveys with participants will inform their preferences for the type of interaction and possible improvements on the current version of the robot.**

I. INTRODUCTION

The current global COVID-19 pandemic has impacted all age groups, but has been most severely affected older adults particularly those in group settings, since the risk for severe illness from COVID-19 increases with age [2]. Given the high contagiousness ratio of the disease, especially via community spread [3], extreme caution and the use of precious Personal Protective Equipment is needed when when assisting older adults with their Activities of Daily Living (ADLs) or Instrumental Activities of Daily Living (IADL) [4]. Long term care facilities implemented these steps to mitigate physical proximity with clinicians and caregivers. Such preventive measures also imply restrictions on personnel and visitor's, directly affecting ongoing research with human subjects at these locations, especially on the deployment of robots which interact with multiple people.

As a result, a different approach towards investigating preferred features in service robots for older adults requiring either hardware modifications (accounting for physical distancing and easiness of sanitation or endowing the robot with vital signs measuring devices for instance), or the type of interaction itself to be adjusted to essential tasks due to the pandemic. Therefore, a task able to combine approaches with objective, subjective and behavioural measures can achieve the initial proposition of deploying a SAR system at an eldercare center (such as a Program of All-Inclusive Care or PACE) and evaluate essential aspects of the interaction:

- Favors the healthcare worker assessment of the patient instead of the robot
- Favors the robot assessing a patient through a routine screening instead of a healthcare worker in close proximity with the patient
- Modifications to the robot such that the former can be improved

Despite this new approach being motivated by the current pandemic, this screening approach will also be useful during the annual flu season, which also threatens older adult population.

A brief introduction to our SAR hardware platform and its modifications is described in Section II, and a new proposed type of interaction which accounts for the aforementioned updated research questions discussed in Section III. Section IV presents conclusion and future work.

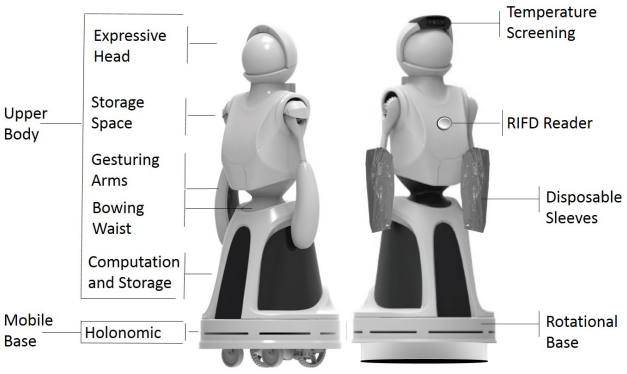

Fig. 1: Quori (left) and hardware modifications for deployment in future studies

II. HARDWARE AND SYSTEM REVIEW

The original goal of this research was to deploy a socially-assistive robot (SAR) at a Program of All-Inclusive Care (PACE) Center. Our modular Hardware Quori (shown in Fig. 1) is made of:

- Holonomic Mobile Base which achieves holonomic motion of the upper torso [18].

This work was funded by the NSF grant PFI:TT 1827673 Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

[1] University of Pennsylvania
[2] Semio AI, Inc.
caio@seas.upenn.edu,
pamelaca@nursing.upenn.edu, ross@semio.ai,
johnmic@pennmedicine.upenn.edu,
yim@seas.upenn.edu

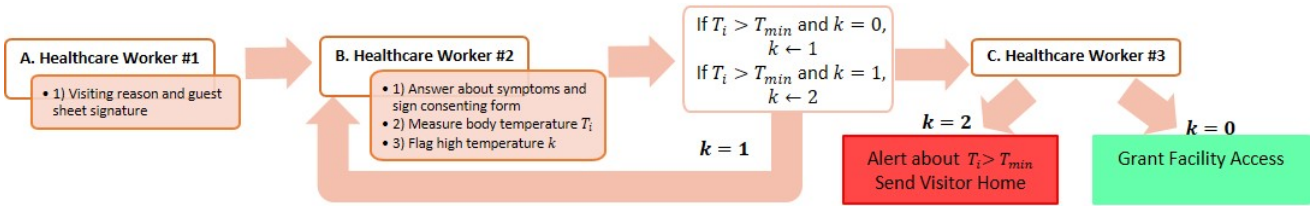

Fig. 2: Screening Procedure at the PACE Center

- Spherical Projection Head: a retro-projected animated face (RAF) for low-cost and flexibility purposes.
- Non-functional Arms: not initially designed for manipulation tasks, and made for gesturing motions.
- Actuated Spine: allowing the robot to lean forward of backwards, and inherently stabilize possible motion vibrations.

One of the modifications to the original hardware is the addition of the Radio Frequency Identification (RFID) reader to the robot. Relying on RFID for person identification is preferred as the subjects will most likely be wearing face masks which may impose challenges to the implementation of facial recognition (although an attempt of doing so is still considered in the study). The check in procedures will most likely require dialogue and indication of directions (for medical appointments for instance) but no autonomous navigation, thus the honolomic base will be simplified to a purely rotational one. As one of the biggest physical indicators of COVID-19 symptoms, fever, a temperature reading of 38^oC can be tracked in a contactless manner by addition of a temperature screening device. Finally, disposable sleeves can facilitate robot sanitation as the arms can be more susceptible to contact even if unintended.

III. Updated Procedures for SAR Deployments at Elder Care Facilities amidst COVID-19 Pandemic

Previously, the thematic analysis completed for this study [22] indicated all stakeholders expectancy for the robot to be polite and personable. In addition, the importance of design and programming in meeting the individual needs of an older adult (either due to their physical or cognitive challenges) was found to be preferred over how the robot should look like. All participants were concerned about the safety of the robot. This is consistent with our previous study that found that any device perceived by older adults, caregivers, or clinicians as unsafe would decrease the use of the technology. This original analysis informed the current SAR platform hardware and software design and do not conflict with the new proposed modifications to the study. The new approach in deploying the robot at elder care facilities aims to consider objective, subjective and behavioral measures. Objective measures will include data such as RFID and facial recognition matching ratio, body temperature entries and symptoms cross-checking. Subjective measures account for the participant's self-report, particularly perceived health using visual analogue scale (VAS) and numeric rating scale (NRS). Finally, behavioral measures will consider the manikin scale [23] and observations of the older adults while interacting with the robot through observer surveys.

The current COVID-19 screening procedure at the PACE Center is illustrated in Fig. 2. A total of 3 people interact with the older adults from arrival to being granted access to the facility or sent home, depending on the assessment of their symptoms and body temperature measurement (repeated at maximum twice). The new proposed procedure will compare the aforementioned assessment with one conducted by the robot, having the three different interactions randomly alternately presented to the participants to capture the different desired measures and avoid any order effects [21] to the study. The qualitative data will undergo a conventional content analysis. Similar to the methodology applied in [17], a post-interaction survey will be conducted with all participants immediately after interaction to evaluate the subjective and behavioral measures previously mentioned. The investigation will consider the Almere model for assessing technology acceptance for older adults[6]. Additionally, an observer survey will inform the research team of additional reactions of the older adults while interacting with the robot. The evaluation criteria will include initial greetings and response, facial expression (smile, neutral, frown) during interaction, active participation, difficulty (or lack of) in understanding and following instructions and observer interaction (actively or by robot error) during the interaction.

IV. Conclusion and Future Work

We propose both hardware and task modifications to the current study of deploying a SAR system in an elder care facility to evaluate its performance on regular screenings with the older adults, in an attempt to comply with the new safety and preventive measures imposed by the COVID-19 pandemic (especially since older adults are the most susceptible population affected by it). The outcome of the study will inform us comparatively how likely are the older adults to be assessed by a SAR and furthermore how equal or distinct are the screening results obtained from the human assessment and from the robot. Finally, we will determine which modifications may be necessary to improve overall acceptance and trust of the SAR among the older adult population in community settings.

REFERENCES

[1] Sefcik, J.S., Johnson, M.J., Yim, M., Lau, T., Vivio, N., Mucchiani, C. and Cacchione, P.Z., 2018. Stakeholders' perceptions sought to inform the development of a low-cost mobile robot for older adults: A qualitative descriptive study. Clinical nursing research, 27(1), pp.61-80.

[2] Centers for Disease and Control Prevention (CDC) - https://www.cdc.gov/coronavirus/2019-ncov/need-extra-precautions/older-adults.html - Accessed on 08/21/2020

[3] Centers for Disease and Control Prevention (CDC) - https://www.cdc.gov/coronavirus/2019-ncov/faq.html - Accessed on 08/21/2020

[4] CA. Smarr et al. "Domestic Robots for Older Adults: Attitudes, Preferences, and Potential," in Int J Soc Robot (2014) 6:229–247 DOI 10.1007/s12369-013-0220-0

[5] J. Pineau, M. Montemerlo, M. Pollack, et al. "Towards robotic assistants in nursing homes: Challenges and results," in Special issue on Socially Interactive Robots, Robotics and Autonomous Systems, Vol. 42, No. 3 - 4, pp. 271 - 281, 2003.

[6] M. Heerink, B. Kröse, V. Evers, and B. Wielinga, "Assessing Acceptance of Assistive Social Agent Technology by Older Adults: the Almere Model," International Journal of Social Robotics, vol. 2, no. 4, pp. 361–375, Dec. 2010.

[7] Johnson MJ, Johnson MA, Sefcik JS, Cacchione PZ, Mucchiani C, Lau T, Yim M. Task and Design Requirements for an Affordable Mobile Service Robot for Elder Care in an All-Inclusive Care for Elders Assisted-Living Setting. International Journal of Social Robotics. 2017:1-20.

[8] D. Seifer and M. Mataric, "Defining Socially Assistive Robotics," in proceedings of the IEEE 9th International Conference on Rehabilitation Robotics June 28 - July 1, 2005, Chicago, IL, USA, 465-468.

[9] Kidd, C.D., 2008. Designing for long-term human-robot interaction and application to weight loss.

[10] Fasola, J. and Mataric, M.J., 2010, September. Robot exercise instructor: A socially assistive robot system to monitor and encourage physical exercise for the elderly. In 19th International Symposium in Robot and Human Interactive Communication (pp. 416-421). IEEE.

[11] Wada, K., Shibata, T., Saito, T. and Tanie, K., 2004. Effects of robot-assisted activity for elderly people and nurses at a day service center. Proceedings of the IEEE, 92(11), pp.1780-1788.

[12] Kim, E., Newland, E., Paul, R. and Scassellati, B., 2008. Robotic tools for prosodic training for children with ASD: A case study. In International Meeting for Autism Research (IMFAR).

[13] Breazeal, C.L., 2004. Designing sociable robots. MIT press.

[14] Ekman, P., Facial expressions//Handbook of Cognition and Emotion/Eds. T. Dalgleish, M. Power. Sussex.

[15] Graneheim, U.H. and Lundman, B., 2004. Qualitative content analysis in nursing research: concepts, procedures and measures to achieve trustworthiness. Nurse education today, 24(2), pp.105-112.

[16] Hsieh, H.F. and Shannon, S.E., 2005. Three approaches to qualitative content analysis. Qualitative health research, 15(9), pp.1277-1288.

[17] Mucchiani, C., Sharma, S., Johnson, M., Sefcik, J., Vivio, N., Huang, J., Cacchione, P., Johnson, M., Rai, R., Canoso, A. and Lau, T., September. Evaluating older adults' interaction with a mobile assistive robot. In 2017 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS) (pp. 840-847). IEEE.

[18] Costa, J.T. and Yim, M.,Designing for uniform mobility using holonomicity. In 2017 IEEE International Conference on Robotics and Automation (ICRA) (pp. 2448-2453). IEEE.

[19] Mucchiani, C., Torres, W.O., Edgar, D., Johnson, M.J., Cacchione, P.Z. and Yim, M., 2018, August. Development and Deployment of a Mobile Manipulator for Assisting and Entertaining Elders Living in Supportive Apartment Living facilities. In 2018 27th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN) (pp. 121-128). IEEE.

[20] Collins, F. and Yim, M., Design of a spherical robot arm with the spiral zipper prismatic joint. In 2016 IEEE International Conference on Robotics and Automation (ICRA) (pp. 2137-2143). IEEE.

[21] Krosnick, J.A. and Alwin, D.F., 1987. An evaluation of a cognitive theory of response-order effects in survey measurement. Public Opinion Quarterly, 51(2), pp.201-219.

[22] Cacchione, PZ, Caio, M., Lima, K., Mead, RR., Yim, M., Johnson, M. (In review?). Older adults, clinicians and caregivers preferences for design features of an affordable mobile service robot in the care of older adults. Special Issue: Interaction in Robot Assistive Elderly Care. Frontiers in Robots and Artificial Intellegence.

[23] Bradley, M.M. and Lang, P.J., 1994. Measuring emotion: the self-assessment manikin and the semantic differential. Journal of behavior therapy and experimental psychiatry, 25(1), pp.49-59.