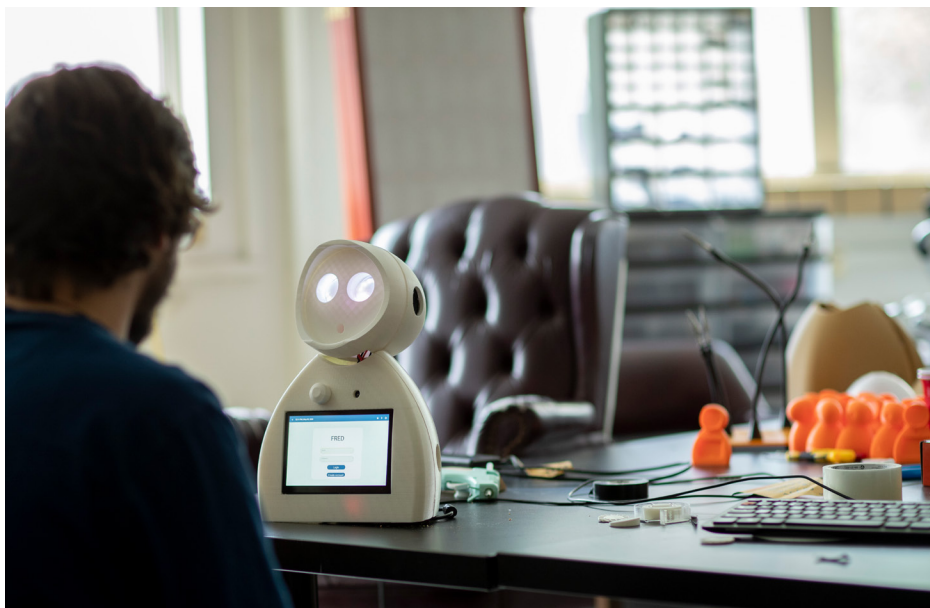# CO-CREATING COMPASSION: Engaging the Alzheimer's Community in Social Robotics for Caregiving

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To view more materials, publications, awards, and images – please visit here.

Examples of UI for the caregiving app and two interface examples for the screen on FRED's chest. All are currently undergoing user testing.
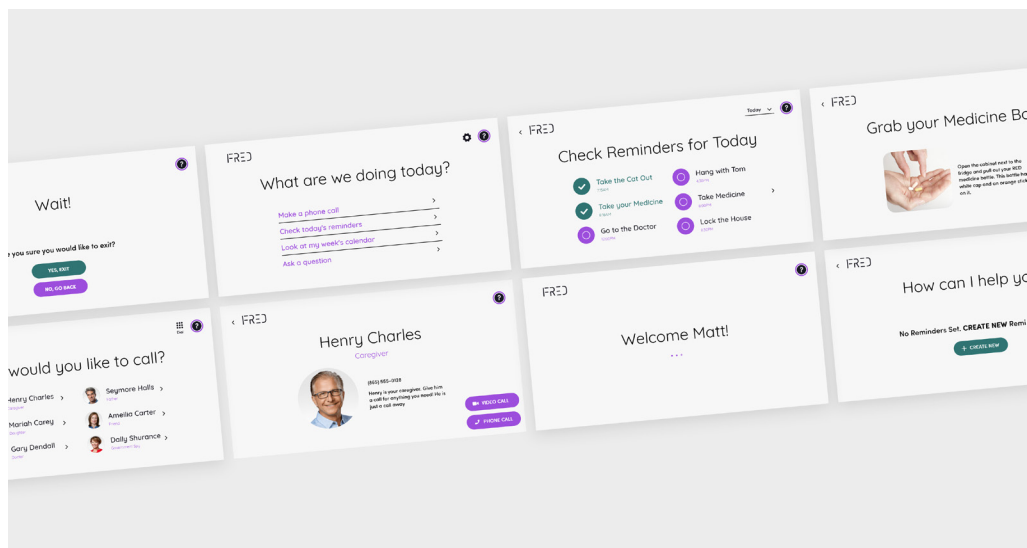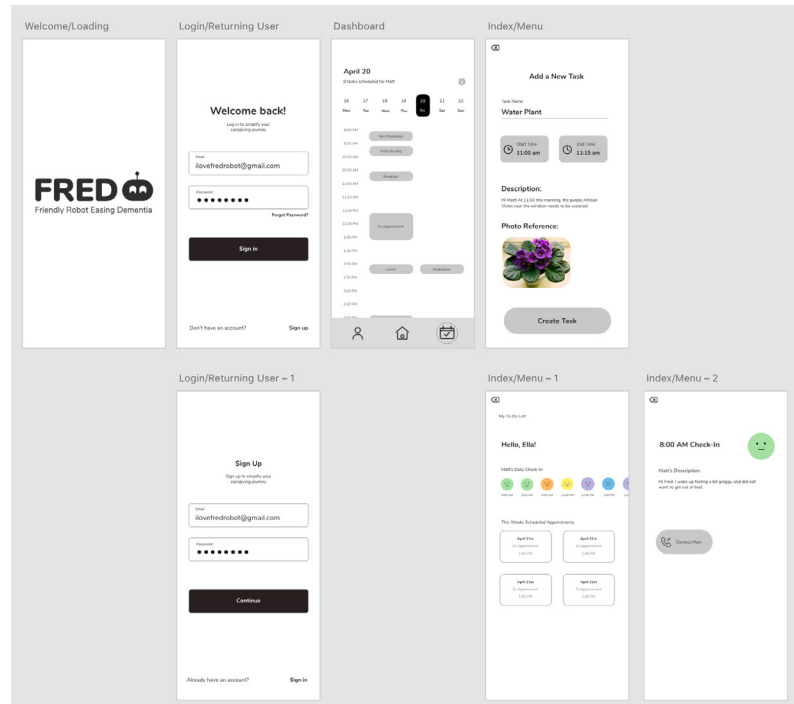
Testing for Acceptance of An Assistive Social Robot for Dementia and Caregiving

Kimberly Mitchell, MFA, Xiaopeng Zhao, PhD
with graduate students Robert Bray, Zachary Cary, John Hooten, Fenpei Yuan
and undergraduate students Cory Blankenship, Juan Casem, Brandon Gardner, Addie-Grace Hopper, Luke Macdougall

THE UNIVERSITY OF TENNESSEE KNOXVILLE

KEYWORDS: *Alzheimer's Disease, Dementia, Caregiving, Activities of Daily Living, Social Interactions, Acceptance, Focus Groups, User Experience, User Testing, Multidisciplinary, Technology, Robots*

INTRODUCTION

Approximately 5.8 million older adults in the U.S. are living with AD and it is estimated that by 2060, this number is projected to triple.

People with AD often require high levels of care and assistance to maintain daily activities. The majority of care provided to a person living with AD or other forms of dementia is from a family caregiver.

The long duration, time-intensive nature of caregiving imposes high burdens on caregivers. There is a great need for assistive technologies and innovative solutions for the future of dementia care because of the increasing rise in adults with dementia.

Using human-centered design, we involved caregivers and people with AD and related dementias in very initial brainstorming sessions on what would be desired in a social robot. Our initial user testing involved working within our University of Tennessee-Knoxville (UTK) community so that our team could work out any bugs and glitches before going to our community partners and testing with older adults, their caregivers, and people with AD and related dementias.

Two versions of our social robot were created – both with the same basic functions and controls, but with different physical builds. The team named the robots FRED, which stands for the Friendly Robot to Ease Dementia.

METHODS

A multidisciplinary team of faculty and undergraduate and graduate students was created to design a low-cost social robot to serve as assistive companions for people with AD.

Focus group participatory meetings with caregivers and those with beginning stages of dementia were held, where the team worked in identifying the audience's needs and robot's responsibilities.

Two final robot designs were tested with undergraduate students (N=15) for general attitudes of acceptance and feelings of overall experience. Our initial user testing experience was completed on our UTK campus in a quiet lab space. The testing began with a signed consent form. Participants then filled out a digital demographic survey, which looked at their age, experience with different technologies, and caregiving experience. After this, users completed the user tasks for Version 1 and then for Version 2 of FRED. At the completion of the user tasks, participants completed a post-test survey, where insights were collected involving their opinions with their interactions of both versions of FRED.

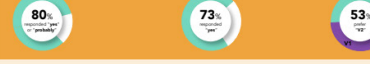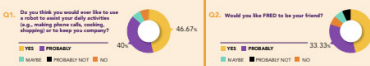

PROTOTYPES OF FRED

VERSION 1 /
V1
VERSION 2 /
V2

RESULTS

100% users were UTK undergraduate students between the ages of **18-30 years old.**

USER TASKS
1. Turn FRED on.
2. Set a reminder to take a sip of water.
3. Create a contact.
4. Call someone.
5. Ask FRED a question.
6. Play a game.
7. Turn FRED off.

ALL USERS TESTED V1 OF FRED FIRST, THEN THEY TESTED V2 OF FRED.
At the completion of their user tasks, users completed a post-test survey. THE RESULTS ARE BELOW:

Q1. Do you think you would ever like to use a robot to assist your daily activities (e.g., making phone calls, cooking, shopping) or to keep you company?

46.67%
40%
YES
PROBABLY
MAYBE
PROBABLY NOT
NO

Q2. Would you like FRED to be your friend?

46.67%
33.33%
YES
PROBABLY
MAYBE
PROBABLY NOT
NO

Q3. What functions do you think the robot can have?
You can choose multiple options.

1.Help me call family and friends 2.Help me contact medical services 3.Help me to do shopping 4.Help me order food 5.Help me to prevent falling 6.Remind me to turn off the stove top 7.Remind me to take my medicine 8.Emergency call service 9.Keep me company 10.Other

Q4. How would you like to control FRED?

80% TABLET + SPEECH
20% SPEECH
0% TABLET / TOUCH SCREEN

Q5. Would you be likely to follow the advice of FRED?

80% responded "yes" or "probably"

Q6. If money were not an issue, would you be interested in purchasing FRED for you or a loved one?

73% responded "yes"

Q7. Did you find Version 1 or Version 2 of FRED friendlier in appearance?

53% prefer "V2"

V2
V1

Users liked the human characteristics of the head and face of version 2 better. Users did not like the high-pitched sound and rapid movement from the servo motor on version 1 – several noted that they were afraid that it would break.

Additional results from the user testing were:
1. The android tablet sounded muffled inside the robot's housing so an external speaker is necessary
2. An external microphone is needed to assist with better voice control
3. The Android system is very buggy – shifting to another platform is recommended

CONCLUSION

Overall, there is promise in using technologies like a social robot to help assist caregivers and people with AD with tasks of daily living. The next step for the platform is to integrate the Android software with a Raspberry Pi in order to reduce cost and modularize the platform. When designing for an older audience, a larger screen size would be ideal. There are more screen size options that pair with a Raspberry Pi system. Adding external speakers and a microphone will ensure that noise is emitted and received crystal clear.

Very careful attention must be made in designing the features of the social robot. Once our revised FRED versions are finalized, our future user testing will include older adults, caregivers, and people with AD and related dementias. We will alternate with half users testing version 1 first and half of the users testing version 2 first to see if there is preference to when the user interacts with the robot.

In the end, our overall cost of the robot is estimated to be less than $300, rendering it possible for wide distribution among the public. Creating a low-cost model is possible and something that should be considered to help address accessibility and healthcare disparity concerns worldwide.

REFERENCES

ALZHEIMER'S ASSOCIATION
AAIC 22
ALZHEIMER'S ASSOCIATION INTERNATIONAL CONFERENCE

CONTACT Kimberly Mitchell: kmitch57@utk.edu
Xiaopeng Zhao: xzhao9@utk.edu

Design and Validation of a Social Robot for Alzheimer's Disease

Kimberly Mitchell, MFA, Luke Macdougall, Robert Bray, Cody Blankenship, Addie-Grace Hopper, Brandon Gardner, John Hooten, Zachary Cary, Fengpei Yuan, Xiaopeng Zhao, PhD

THE UNIVERSITY OF TENNESSEE KNOXVILLE

On Aging

INTRODUCTION

Alzheimer's disease (AD) is the most common form of dementia and is associated with memory loss and cognitive impairments that affect daily life. Approximately 5.8 million older adults in the U.S. are living with AD. People with AD often require high levels of care and assistance to maintain daily activities. The majority of care provided to a person living with AD or other forms of dementia is from a family caregiver, representing 18.6 billion hours of unpaid care valued at $244 billion. The long duration, time-intensive nature of caregiving imposes high burdens on caregivers.

Within recent years, the emergence of social and medical assistive technologies has become more pronounced. These human oriented assistive technologies were primarily based to serve the older population (adults > 60 years of age) with their daily lifestyles or special medical needs. Several corporations and governments endorse the potential in expanding assistive technologies to not only take better care of the aging, but to also reduce the burden of younger caretakers. Medical automatons, handheld robots, and virtual assistants are some of the few forms of assistive technology becoming available to the public today.

Many of the current technologies have high price points, making access to them very difficult. A team of faculty at the University of Tennessee-Knoxville led students in Mechanical, Aerospace, and Biomedical Engineering, Computer Science, Graphic Design, and Architecture to create a low-cost social robot to assist Alzheimer's and dementia patients with daily tasks and relieve caregivers of some responsibilities.

Two different body design prototypes were created and their functions were tested among a group of college-aged students (N16). Results from the testing were helpful in identifying changes to make to the next prototype iteration, which will be tested at several local stakeholder locations – a community senior center, a disability advocacy center, an assisted living facility, and a memory care unit.

METHODS

A literature scoping review was completed that evaluated the effectiveness of various assistive technologies done from other social robot research papers. The data was analyzed in conducting their performance and acceptance. Several stakeholder focus group meetings with early onset dementia patients and their caregivers were held. The team brought several existing humanoid robots to the focus groups and had open ended discussions on what the potential users liked, didn't like, and what they would want in a social robot at home. Later, information was extrapolated to make calculated judgments on creating two unique and affordable robot prototypes able to aid Alzheimer patients and their caregivers in helping with activities of daily living.

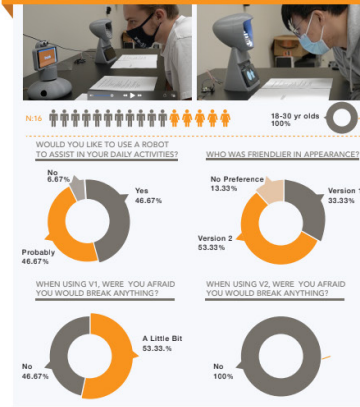

The team identified essential tasks that the social robot needed to be able to do for the initial user testing. The 6 essential tasks included: *[1] Turn the robot on, [2] Set a reminder, [3] Make a phone call, [4] Play a game, [5] Ask the robot a question, and [6] Turn the robot off.* Two prototype robots were created and printed using 3D printers.

For the user-testing, previous literature on social robots use with dementia and Alzheimer's patients were utilized to obtain and create measurement items for a pre and post user-testing questionnaire. The pre user-testing questionnaire consisted of an introduction to the testing and a demographic survey which also answered any caregiving background. After completing the 6 user tasks with each prototype, users completed a post user-testing questionnaire, asking about feasibility, acceptability, and preference to the two robot options.

INITIAL PROTOTYPE DESIGNS

VERSION 1 /

This example stands 8" tall, with a rounded base, a tablet screen and 2 lights above. The tablet screen has a mouth built into the UI, so when the robot is talking to the user the mouth is animating. The body shape is abstract and the tablet is the main emphasis. The servo motor allows the robot to twist around 180 degrees.

VERSION 2 /

Version 2 is a stationary robot where the tablet is built into the chest cavity. This stands 12" high. The main emphasis on this robot is the robot face, which has 93 LED lights that pulsate and emit color to show engagement and interaction with the user.

MATERIALS /

Samsung tablet cost approx. $120
Servo motor cost approx. $4
Ultrasonic sensor/lights cost approx. $7
Samsung tablet cost approx. $120
LED lights cost approx. $24

USER-TESTING + RESULTS

N:16

18-30 yr olds 100%

WOULD YOU LIKE TO USE A ROBOT TO ASSIST IN YOUR DAILY ACTIVITIES?

No 6.67%
Yes 46.67%
Probably 46.67%

WHO WAS FRIENDLIER IN APPEARANCE?

No Preference 13.33%
Version 1 33.33%
Version 2 53.33%

WHEN USING V1, WERE YOU AFRAID YOU WOULD BREAK ANYTHING?

A Little Bit 53.33.%
No 46.67%

WHEN USING V2, WERE YOU AFRAID YOU WOULD BREAK ANYTHING?

No 100%

RESULTS

Several iterations of the robot's body were produced using AutoCad and Rhino software to build the 3D models, and printed using the Prusa i3 MK3S+ printer. Many variations of filament color were explored.

The low-cost social robot was created by utilizing the principles behind the scoping review methodology to assess the efficacy of implementing social robot technology into homes and facilities for the aging and medical patients. A human centered design approach by completing focus groups and conducting initial user-testing for feasibility and acceptability was also conducted. From the initial user-testing, the research team noted that 53% preferred version 2 over version 1 design. Users did not like the high-pitched sound and rapid movement from the servo motor on version 1 – several noted that they were afraid that it would break.

Additional results from the user testing were: [1] The android tablet sounded muffled inside the robot's housing so an external speaker is necessary, [2] An external microphone is needed to assist with better voice control, [3] The Android system is very buggy – shifting to another platform is recommended.

FUTURE DIRECTION

hello, jean.
hello, jean.

The next step for the platform is to integrate the Android software with a Raspberry Pi in order to reduce cost and modularize the platform. Plans for the future design include a robot that can readily communicate and respond to a user. When designing for an older audience, a larger screen size would be ideal. There are more screen size options that pair with a Raspberry Pi system. Adding external speakers and a microphone will ensure that noise is emitted and received crystal clear. The view of the tablet screen will be unobstructed and at a good angle. And lastly, that the robot is visually appealing to interact with while hiding all the circuitry.

Additional changes that will be made based on the user- testing are the integration of a dialogue management system based on machine learning to allow the robot's dialogue system to adjust to an appropriate rate of asking a follow-up question. This addition could distract the person with AD from repetitive behaviors, which is a suggested caregiving strategy. Adding a cognitive assessment and cognitive training programs using the social robot will also improve the quality of life for people living with AD.

CONCLUSION

There are many benefits in using a social robot to help assist caregivers and people with AD with tasks of daily living. Very careful attention must be made in designing the features of the social robot. Using 3-D printing technology and a tablet, the team was able to create a robot that will be capable of having natural conversations with human users. The overall cost of the robot is estimated to be less than $300, rendering it possible for wide distribution among the public. Creating a low-cost model is possible and something that should be considered to help address accessibility and healthcare disparity concerns worldwide.

REFERENCES

Samples of some user testing results and published posters at two peer-reviewed conferences. To view more FRED presentations, click here.

Examples of some awards received from publication. To view full publications, click here.

2022 HSSE Conference Best Paper Awards

August 5, 2022 by Jim Spohrer

The ISSIP Awards Committee is delighted to issue Knowledge-Sharing Eminence – ISSIP Digital Badges to recognize the following winners of 2022 Human-Side of Service Engineering (HSSE) Conference best papers awards as well as honorable mentions paper awards. Also, see award certificates here. Awardees can add their ISSIP digital badge to their LinkedIn profile by following instructions here.

Award Type: First Place Best Paper Award

Paper: Value Creation Through Third-Party Certification – Case Study of Phase-Free Certification for Certifying Disaster Prevention
Author(s): Aki Shimbo (B), Amna Javed (B), Hideomi Gokon (B), Youji Kohda (LI) (B)

Award Type: Second Place Best Paper Award

Paper: Designing a Multi-disciplinary Class to Create a Social Robot for Alzheimer's
Author(s): Kimberly Mitchell (LI) (B), Xiaopeng Zhao (LI) (B), John Hooten (B), Robert Bray (B), Luke Macdoughall (B)

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Jim Spohrer 27 Mar
ITQM 2023 - Oxford, UK
http://itqm-meeting.org/2023/@The_ISSIP #ISSIP
Twitter

Sinead Horgan 17 Mar
Surgical site infection (SSI) is a global patient safety issue. Data drives reductions in SSI rates. Identifying patients @ risk to prevent infections #ISSIP #surveillance #multidisciplinary @SSIPreventionD @MaryFitzm12 @BridAOSullivan @NSujamol @gillianmconway #recognisesepsis

HSSE-ISSIP Best Paper Award 2023
Process and Jury

Pre-Selection of 12 Papers based on ratings

"External" Best Paper Committee

HSSE-ISSIP Best Paper Award 2023
+ 3 Honourable Mentions

Best Paper Committee:
- Jim Spohrer, USA
- Lou Freund, USA
- Walter Ganz, Germany
- Kazuyoshi Hidaka, Japan
- Alessandra Amendola, Italy
- Wojciech Cellary, Poland
- Yuri Misnikov, UK
- Andrea Kő, Hungary

Process (suggestion):
- Blind-review-rating by 2 committee members each regarding criteria:
  - Quality of Paper (0-10)
  - Contribution to HSSE (0-10)
  - Originality (0-10)
- Best Paper Award and honourable mention papers of conference based on ratings

HSSE 2023 Co-Chairs
Christine Leitner, Clara Bassano, Jens Neuhüttler, Debra Satterfield

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ISSIP - HSSE 2023 Best Paper Awards

2023 HSSE Conference Best Paper Awards

July 20, 2023 by Jim Spohrer

The ISSIP Awards Committee is delighted to issue Knowledge-Sharing Eminence – ISSIP Digital Certifications to recognize the following winners of 2023 Human-Side of Service Engineering (HSSE) Conference best papers award as well as honorable mentions paper awards. Also, see award certificates here. Awardees can add their ISSIP digital certification to their LinkedIn profile by following instructions here. All the HSSE 2023 conference papers can be found here open access. Also, see ISSIP-HSSE 2023 Welcome Remarks, HSSE History, ISSIP Sponsorship (recording) (presentation) as well as ISSIP-HSSE 2023 Best Paper Award (recording) (presentation).
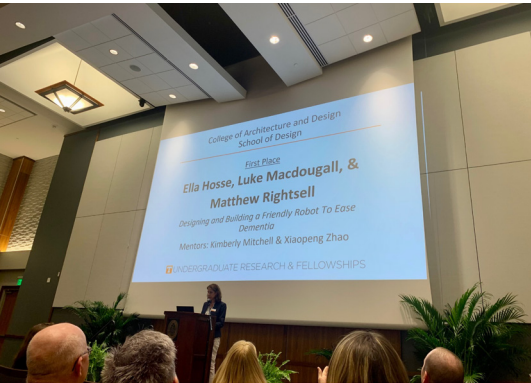
Award Type: Best Paper

Paper: The role of Data and AI during development of Smart Services
Author(s): Rainer Nägele (LI) (DC),
Jens Neuhüttler (LI) (DC)

Award Type: Honorable Mention
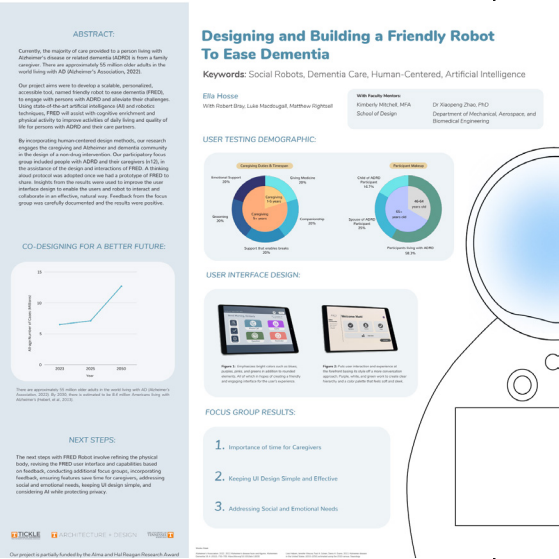
Paper: Co-Designing a Friendly Robot to Ease Dementia
Author(s): Kimberly Mitchell (LI) (DC),
Xiaopeng Zhao (LI) (DC)
Robert Bray (LI) (DC)
Luke MacDougall (LI) (DC)
Ella Hosse (LI) (DC)
Matt Rightsell (LI) (DC)

EURēCA 2023: Thank You Faculty/Research Mentors!

VP ○ **Vice Provost for Student Success <vpss@utk.edu>**
To: ⊗ Mitchell, Kimberly Marie; **Cc:** ● Lowe, Sarah ⌄

Monday, May 8, 2023 at 9:51 AM

Dr. Kimberly Mitchell,

The 27th Annual "Exhibition of Undergraduate Research and Creative Achievement" (EURēCA) was a tremendous success! We in Undergraduate Research and Fellowships (URF) want to express our sincere gratitude and thank you for your mentorship of our undergraduate researchers.

This year's exhibition featured 1,179 students showing 868 projects from a wide range of disciplines and methodologies. Student research was overseen by 331 faculty mentors, as well as postdocs and graduate students helping to mentor undergraduates in their research groups.

We in URF continue to be impressed with the quality of the projects and the dedication our undergraduate students commit to their research endeavors, that is no doubt due in large part to the mentorship provided by folks like yourself.

Your involvement in a high-impact practice, such as undergraduate research, is essential to our student achievement efforts. We know you are busy, but we want you to know your work has not gone unnoticed! Our campus is better because of faculty and research mentors like you who make experiences like undergraduate research possible.

Thank you for your time, dedication, and mentorship.

In the Volunteer spirit,

Pat Akos
Associate Vice Provost for Student Success

Erin Darby
Faculty Director for Undergraduate Research & Fellowships

Laura De Furio
Acting Director for Undergraduate Research & Fellowships

Example of peer-reviewed undergraduate research award, overseen by Kimberly Mitchell

To see detailed view of poster, click here.

Re: Comments from EUReCA

EH ⊗ **Ella Hosse <ehosse@vols.utk.edu>**
To: ⊗ Staples, Cary; **Cc:** ⊗ Mitchell, Kimberly Marie ⌄

Thursday, April 27, 2023 at 9:03 PM

Ella

An obviously extensive amount of research went into / continues with this project - potentially very sensitive and emotional work has been done so well

This is a perfect marriage of the art of interface design and deep medical science to address a very real and increasing problem - with sensitivity and direct consideration of users

Great visual and verbal presentation of an incredible concept / product - i cannot say enough how impressed i was by this piece and am so looking forward to seeing its further development. This is a potential life-changer for a lot of people.

Incredible job in research and distilling information. Such a well researched and thoughtful project.

Excelled at collaboration and problem solving.

Incredibly impressive project. This was well researched and beautifully communicated. Great work!

research has informed iterations on design/ interface etc.

The project is a collaboration between the school of design and engineering

IRB approval
Excellent process. Would like to see more documentation.

Good team. Works well together.

A research experience can be a transformative learning opportunity that helps individuals develop skills, ask interesting interesting questions, and propose innovative solutions that will help society. This project represents all facets of this unique opportunity.

Extremely well researched, used many styles of hands on research, both traditional and design related.

Has many research partners in appropriate disciplines to drive the project forward and seems genuinely thrilled about the insights that arise form that.

Very clearly stated current learnings and plans that were made to gather more info and make changes based on those learnings. Very impressive project.

From: Staples, Cary
Sent: Thursday, April 27, 2023 6:07 PM
To: Hosse, Ella C <ehosse@vols.utk.edu>
Cc: Mitchell, Kimberly Marie <kmitch57@utk.edu>
Subject: Comments from EUReCA

Hi Ella,

Congratulations on your performance at EUReCA. Everyone was very excited about your project. Your love of what you do really shows.

Please let me know if you or Kimberly have any questions.

Cary