Alexa Eldercare Toolbox: *A Smarthome Solution for the Elderly*

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***Abstract*—This paper examines the issue of providing care to an increasing elderly population presenting a strong desire to continue living at home. A smart home system designed to operate via an Amazon Echo, the Alexa Eldercare Toolbox, was designed to address some of the everyday struggles faced in the home eldercare scenario. A specific focus was placed on addressing the needs of Alzheimer's patients, who struggle more than the rest of the population to tend to their own needs. Measures were also taken to assist the patients' caretakers, who are so often forgotten in this context. An examination of the problem, a description of the Alexa Eldercare Toolbox and how it was developed, a discussion of the implications of this potential solution, and a listing of next steps are provided in this text.**

Keywords— eldercare, senior citizens, smart homes, home automation, assisted living

I. Introduction

Every day, scientists and healthcare professionals are making strides that allow individuals to live longer, healthier lives. With these advances, though, comes a dramatic shift in the demographics of the American population. According to the Population Reference Bureau, the number of Americans aged 65 and older is expected to approximately double by the year 2060, based on figures from 2018. With 95 million people, the 65-and-older group will make up about 23% of the total population [17]. Moreover, as it is now, one in ten people aged 65 and older has Alzheimer's disease. Alzheimer's disease is "an irreversible brain disease that slowly destroys memory skills, thinking skills and, eventually, the ability to carry out daily activities" [1]. This disease, therefore, only serves to complicate the already difficult process of just getting through the day as a senior citizen.

The increase in this sector of the population carries with it a growing demand for old-age care. According to the U.S. Department of Labor, by the year 2024, over 1.6 million new jobs will have been created in the eldercare field, and just over 20% of these jobs will specifically be in the field of home health care [20]. However, because home health care can become expensive, an increasing interest in smart home systems to help provide eldercare has arisen. In short, there exists a diverse host of issues to be managed when it comes to aging in place, and more energy is being put into using tech to solve them. The next section takes a more detailed look at what the situation is that has necessitated such an exploration of the capabilities and uses of technology in this light.

II. Problem

A. Desire to Age in Place

As reported by the American Association of Retired Persons (AARP), many seniors admit that it is becoming more difficult for them to live without any assistance [21]. Despite the difficulties they admittedly face, though, in a survey conducted by the AARP, 90% of seniors reported that they plan on staying in their current homes for the next five to ten years [21]. Moreover, according to Esther Iecovich of Ben-Gurion University, moving to a senior facility is often thought of as a last resort, prompted significantly by the "inadequacies of the home to meet the changing needs of older people due to decline in health and self-care abilities" and other limiting factors [11]. From this statement, it is clear that seniors' desires tend to be at odds with the ability of their homes to satisfy their needs.

B. Cost of Eldercare

Even when family members can convince their loved ones that they need to move into a nursing home, there comes

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the hurdle of cost. According to an article published by National Public Radio, senior care costs can range from just over $18,000 annually for adult day services to almost $90,000 per year for a private room in a nursing home [9]. Insurance companies rarely cover long term care costs, and Medicare only covers approximately 100 days of nursing home care. Moreover, according to Marilyn Moon, building on a report by Cubanski, Swoope, Damico, and Neuman, those individuals who require long-term care tend to spend significant resources on fulfilling acute care needs in addition. "On average, about 87 percent of out-of-pocket spending by older adults is for acute-care services- or $4,219 per person in 2010. And, out-of-pocket spending steadily increases for all types of services for those with chronic conditions or restrictions on [activities of daily living]" [18][6]. Altogether, for most families, these costs are a major blow.

C. Overextended Eldercare Workers

If cost does not prove to be an insurmountable issue, there remains the problem of the extreme amount of strain placed on eldercare workers. As stated by Leslie Kernisan, geriatrician and former health services researcher, "The right kind of technology [in eldercare] could enable clinicians to provide more geriatrics care per unit of time, which is extremely valuable given the shortage of personnel trained in geriatrics" [14]. A main source of difficulty in the field of eldercare is simply ensuring there are enough properly-educated people ready and willing to take care of the increasing number of older individuals. As a result, some nursing home patients may experience a degree of neglect that negatively affects their health and may contribute to their physical and mental decline.

Along the same lines are the issues involved in being a home health aide. Constantly providing care for someone can obviously be physically exhausting. Somewhat less obviously, though, caregivers may also become emotionally exhausted [4]. Caregiver burnout has proven to be such a pressing issue that researchers at the University of Clermont Auvergne have attempted to develop a supervised learning system that can predict when caregivers will reach the point of burnout so that respite care can be introduced before that point is reached [3]. Additionally, because caregivers spend most of their time with their patient, other relationships often suffer.

III. Proposed Solution

As asserted by Stephen L. Dawson and Christopher A. Langston in the Journal of the American Society on Aging, "As innumerable healthcare delivery reform efforts have attempted to address the complex and high-cost needs of older adults, such efforts have again and again been frustrated by a lack of staff with the skills and attitudes required to bear the weight of those reforms" [7]. It is quite evident from this repeated frustration that the change needed in the workforce is not something that can or will happen overnight. Hence, smart homes present themselves as a potential solution to not only help bridge the gap, but also to help reduce the workload required of this desired workforce.

The following sections detail the proposition of a solution for the elderly population, with a special focus on the needs of Alzheimer's patients. The Alexa Eldercare Toolbox is a smart home solution composed entirely of Alexa skills available on any of Amazon's Echo devices. These skills come together to provide minimally invasive and economical assistance to the patient, making their daily life safer and more comfortable. Additionally, the toolbox strives to help deliver peace of mind to family members as well as assistance to caregivers, making the system a holistic solution to the concerns involved in a typical eldercare scenario.

Thirteen skills are offered as part of the Alexa Eldercare Toolbox. Users may install any combination of the 13 skills as they see fit, making the toolbox adaptable to the lives of the unique individuals using it. Setup and installation of the toolbox is simple. After purchasing an Amazon Echo, the user plugs the device into a power outlet. Then, the Alexa app is installed on a smartphone, tablet, etc. and used to connect the Echo to the WiFi network in the home. Once connected to WiFi, any skill can be enabled via the Alexa app or by simply asking Alexa to enable a particular skill.

A. Features

Listed here are the skills offered by the Alexa Eldercare Toolbox. Provided with each is a brief discussion of the problem that spurred the development of the skill, a description of how the system attempts to solve the problem, and a mention of potential triggers that might be used to automate the skill's usage in the home.

Alzheimer's Screening Tool

- Problem: As individuals age, their loved ones may notice slight lapses in memory or behaviors that seem out of the ordinary. When these changes occur, many people become concerned about their loved ones.
- Alexa Skill: The Alzheimer's screening tool Alexa skill was developed to help individuals assess their loved one's mental state. The General Practitioner assessment of Cognition is publicly available on the internet [12]. The "Informant Interview" questions from this assessment were transcribed into an Alexa skill. Upon launching this skill, Alexa asks the user a series of questions about their loved one to which they can respond "yes," "no," or "don't know." Then, Alexa provides an assessment of the affected individual's current mental state.
- Potential Trigger: N/A. Can be used at any time at discretion of caregiver or loved one.

Kitchen Safety

- Problem: At all ages, there is the potential for an individual to accidentally leave the stove on. The risk of this scenario occurring increases as one ages and naturally becomes more forgetful.
- Alexa Skill: The kitchen safety Alexa skill helps the user to use the stove more safely. Upon being activated, the

skill provides the user with guidelines on how to use the stove to minimize danger. It then asks the user for how long they will be cooking and automatically sets a timer. Once the timer is up, Alexa checks in with the user and asks them to turn the stove off.

- Potential Trigger: This skill can be automatically launched by setting up an Alexa Routine. A temperature sensor can be installed above the stove and used as a trigger, and upon the temperature crossing a certain threshold that indicates the stove is on, Alexa can start the kitchen safety skill.

Tooth Brushing Walkthrough

- Problem: Individuals with Alzheimer's forget how to perform daily tasks as they progress to later stages of the disease. One of these tasks essential to good health is toothbrushing.
- Alexa Skill: The toothbrushing Alexa skill serves as a complete walkthrough of the toothbrushing process for those who need assistance. The walkthrough starts at the very beginning, with picking up a toothbrush and toothpaste, and works all the way through the two minute brushing process, telling the user when to brush which sections of their mouth. Finally, it finishes by providing instructions on rinsing one's mouth and giving a reminder to turn off the faucet.
- Potential Trigger: This skill can be automatically run twice a day, once in the morning and once in the evening. An Alexa Routine can be set up with time and recurrence frequency as the trigger and with the launch of this skill as the response. This will help the patient maintain a healthy oral hygiene regimen.

Balanced Meal Builder

- Problem: Many Alzheimer's patients suffer from malnutrition. Often it is the case that these patients struggle to remember what constitutes a balanced meal, neglecting to consume proteins, carbohydrates, and fruits and vegetables in an appropriate combination each day.
- Alexa Skill: The balanced meal builder Alexa skill asks a series of questions to verify that the patient has included a protein, a starch, and a vegetable in their meal. If they have not, it provides suggestions on how to balance out the meal.
- Potential Trigger: The patient might benefit from having this skill configured for automatic launch at their typical meal times. This can be accomplished by creating an Alexa Routine with time and recurrence frequency as the trigger and the launch of this skill as the response.

My Diet Helper

- Problem: Elderly individuals are often prescribed a particular diet by their doctor in order to maintain their health. These diets, however, may be unfamiliar to the patients or, even if they have heard of them before, may be difficult to remember.
- Alexa Skill: The diet helper Alexa skill helps patients keep track of the foods they can and cannot eat. Upon launching the skill for the first time, Alexa asks the patient what kind of diet their doctor has prescribed for them. After telling Alexa what diet they are on, the skill can be used in the future by simply launching the skill and asking Alexa whether they are allowed to eat a certain food.
- Potential Trigger: N/A. Can be used at any time at discretion of the patient.

Dressing Assistance

- Problem: Individuals with Alzheimer's forget how to perform daily tasks as they progress to later stages of the disease. One such task is getting dressed. Once the patient progresses to a point where they cannot dress themselves, they will require assistance from a caregiver. However, this can be uncomfortable and might feel demeaning.
- Alexa Skill: The dressing assistance Alexa skill verbally walks the patient through the process of getting dressed. The first time the skill is launched, the caregiver is asked to configure what pieces of clothing should be included in the routine. Once the routine is configured, Alexa asks the caretaker to label each of the patient's drawers with pictures of the types of clothing inside. At this point, the skill is ready to be used and will walk the patient through the dressing process each time the skill is launched.
- Potential Trigger: This skill can be configured to launch at a particular time each morning by creating an Alexa Routine with time and recurrence frequency as the trigger and the launch of this skill as the response.

Depression Screening

- Problem: Many elderly individuals, if they choose to stay in the home, end up living alone. If they are not visited frequently by loved ones, prolonged periods of loneliness can lead to feelings of sadness and depression. It should be noted that caregivers might find this skill useful as well. Caregivers may become emotionally exhausted when constantly tending to a patient. Their relationships with other people in their lives may become strained. All of this stress can build up, putting caregivers at significant risk for depression as well.
- Alexa Skill: The depression screening Alexa skill takes the questions of the Patient Health Questionnaire-9, a standardized depression screening questionnaire [19], and administers them to an individual. The individual answers "yes" or "no" to a series of questions, and, upon answering all of them, Alexa assesses and provides feedback on whether the user might be experiencing depression (and to what degree) based on their answers.
- Potential Trigger: N/A. Can be used at any time at discretion of the patient or caregiver.

Fall Risk Assessment

- Problem: As individuals grow older, many become less steady on their feet. As a result, many end up falling and injuring themselves. In fact, according to the World Health Organization, 37.3 million falls are severe enough to require medical attention each year, and about 646,000 falls per year are actually fatal [10].
- Alexa Skill: The fall risk assessment Alexa skill asks the caretaker a number of questions regarding the health of their patient, based on the CDC's recommendations [16]. Additionally, it leads the caretaker through some simple tests to help assess a patient's balance and strength. The results of these tests, along with the answers to the questions about the patient's health, are used to determine whether the patient might be at risk of falling.
- Potential Trigger: Can be used at any time at discretion of the caregiver.

Smartphone Helper

- Problem: Smartphones were not ubiquitous when the world's current elderly population was growing up. As a result, many are uncomfortable using them.
- Alexa Skill: The smartphone helper Alexa skill, upon being launched for the first time, asks the user whether they are using an iPhone or an Android. It then saves this response and uses it to provide instructions on phone usage to the user. For instance, the user can ask, "How do I make a call?" or "How do I text someone?" and Alexa will reply with step by step directions based on the type of phone the person has.
- Potential Trigger: N/A. Can be used at any time at discretion of the patient.

Medication Setup

- Problem: Caretakers have so many responsibilities that it can be difficult to remember all of them and do them all properly. If the caretaker were to forget to portion out and set up the patient's medications for the week, this could be severely detrimental to the patient's health.
- Alexa Skill: The medication setup Alexa skill walks the caretaker through the process of setting up their patient's medications in a pill organizer each week. It asks the caretaker a series of questions in a checklist format to make sure that they have enough medication for the week, checks in about the need for refills, ensures that the medication has been portioned out in a daily pill organizer, and more.
- Potential Trigger: This skill can be configured to be launched at the beginning of each week to help keep the caregiver accountable for properly setting up the patient's medications for the week. An Alexa Routine can be created with time and recurrence frequency as the trigger and the launch of the skill as the response.

Medication Reminder

- Problem: Elderly individuals, and especially Alzheimer's patients, often struggle to remember to take all their medications at the right times. If they do not take their medications, their health might suffer significantly.
- Alexa Skill: The medication reminder Alexa skill reminds the patient to take their medications, as laid out by their caregiver. This skill works hand in hand with the previous one, as, once the caregiver has laid out all the pills in a daily organizer, this skill helps the patient take the correct ones.
- Potential Trigger: This skill can be configured to be launched as often as the patient needs to take their medications to help ensure that all prescriptions are being taken as needed. An Alexa Routine can be created with time and recurrence frequency as the trigger and the launch of the skill as the response.

Night-time Checklist

- Problem: In order to remain healthy and safe, there are a number of activities that an Alzheimer's patient should complete each night. These include brushing teeth, taking medications, clearing a path to the bathroom, etc. It can be difficult to remember all of these tasks.
- Alexa Skill: The night-time checklist Alexa skill details a series of actions for the patient to take when getting ready for bed. It asks the patient a series of questions to verify whether they have completed the tasks that will help keep them safe and healthy each night.
- Potential Trigger: This skill can be configured as an Alexa Routine to be triggered each night at the patient's bedtime. An Alexa Routine can be created with time and recurrence frequency as the trigger and the launch of the skill as the response.

Brain Game

- Problem: When individuals live alone or do not go out often, they tend to receive less mental stimulation than they used to. The less a patient actively uses their brain, the more likely the brain's functionality is to decline.
- Alexa Skill: The brain game Alexa skill is a simple word association game. Alexa states two words and then presents the user with three word choices. The user's job is to choose the word from the three choices that connects the first two words. Alexa keeps score and provides the user with their score at the end of the game.
- Potential Trigger: N/A. Can be used at any time at discretion of the patient.

B. Smart Home Action Points

A floor plan is presented below to indicate some of the key action points of the Alexa Alzheimer's Toolbox. While some of the skills can be used anywhere, it makes most sense to use some at particular locations within the home. Namely, the dressing assistance skill, kitchen safety skill, balanced meal and diet helper skills, and toothbrushing skills are heavily associated with particular locations and are marked on the diagram below. This floor plan assumes a one-floor home, as many elderly individuals live on one floor to avoid having to deal with stairs. It should be noted that the Amazon Echo device is placed in the

center of the home to maximize the number of points from which Alexa is accessible, though multiple Echoes could be used in a larger home area.

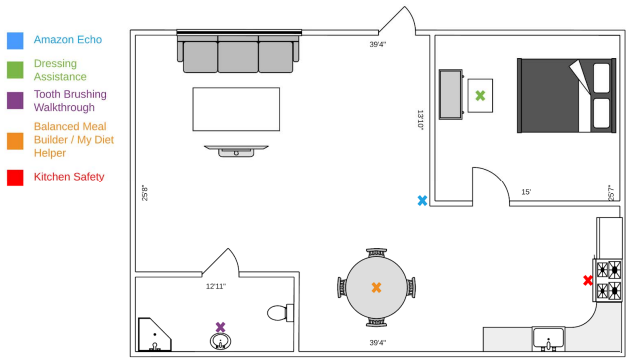

Fig. 1. Smart Home Action Points

IV. Materials and Methods

A. Materials

- Laptop (for skill development and testing)
- Amazon Echo Dot (second generation)
  - Note: Could increase the number of Dot devices used to cover a larger home area
- Smartphone with Amazon Alexa app (for skill testing)
- WiFi Connection (for skill development and testing)

B. Methods

Amazon Echo Dots are home assistant devices designed to interact with users using built-in speech recognition and processing capabilities. These capabilities were leveraged in the creation of the 13 skills comprising the Alexa Eldercare Toolbox. Each Alexa skill was created via the Alexa Developer Console, a platform offered by Amazon for the purpose of skill development. The front end of the voice user interface (VUI) for each skill was synthesized via the "Build" tab of the Developer Console. Several intents were added to allow the user to interact with each skill, where an intent is a verbal trigger provided by the user that prompts some particular response from Alexa. Slots were added to the intents to retrieve specific information from the user, as needed.

The backend was fleshed out through the "Code" tab, where an AWS Lambda function was written to handle all the interaction with the user. Several handlers were written in the code, where each intent built into the front end must be handled by a function on the backend, so that Alexa knows how to properly respond to various user inputs. State management was employed, where necessary, to help keep track of which of Alexa's statements the user was responding to.

Finally, the "Test" tab was used, in tandem with an Amazon Echo, to confirm the functionality of each skill. The Alexa Simulator on the test tab helped verify the basic flow of dialog for the skills, while the Echo was used along with the Alexa app to test more complex functionality, like setting timers and reminders via skills.

V. Discussion

It is important to understand the benefits and drawbacks of the solution proposed above. With so many eldercare tech options being developed, what is it that makes the Alexa Eldercare Toolbox a worthwhile choice, and what are the areas in which work needs to be done?

Before diving into the benefits arising from the specifics of the toolbox, one less obvious but extremely important pro to smart eldercare that must be addressed is its ability to facilitate contagion risk minimization. As COVID-19 has so glaringly demonstrated, nursing homes are a hot spot for the spread of diseases, which, in old age, can often be fatal. In fact, nearly 40% of all COVID-19 deaths in the United States occurred in nursing homes (among both the patients living there and the employees of the facilities). Even in times when a pandemic is not plaguing the globe, it can be extremely difficult to contain the spread of disease in eldercare facilities [15], where patients live in close quarters and interact with one another and with caretakers so heavily on a daily basis.

If, instead of living right down the hall from potentially sick patients, elderly individuals could remain in their own homes, the risk of contagion would be dramatically reduced. Living at home, though, only becomes a potentially valid option when measures have been taken to ensure that this environment is safe and comfortable for the elderly individual. If no one is there to remind them to take their medications or to help them remember how to get dressed in the morning, then living at home is likely not viable. However, when the Alexa Eldercare Toolbox is introduced, at least some of the difficulties that previously made a nursing home necessary can potentially be alleviated.

Now looking more at the pros of the toolbox specifically, there are a number of merits to be considered, namely low cost, non-invasiveness, and ease of setup and use. Many smart home systems cost thousands of dollars, between hardware, software, installation, and maintenance costs. The Alexa Eldercare Toolbox stands, then, as an attractive option to individuals looking to procure some measure of technological safety for their loved ones. At this point in time, the third-generation Echo Dot can be purchased for around 30 USD. When compared to the tens of thousands of dollars already spent by families on eldercare, this amount may be feasible for many people.

Moving on from finances, the Alexa Eldercare Toolbox is also an attractive option because of how non-invasive it is. Alexa does not record any user speech until the wake word (default programmed to be "Alexa") is spoken, at which point the user's request is captured and sent to be processed [5]. This means that users can be confident that their personal information and conversations are kept private, making Alexa an unobtrusive part of the home.

Once the Echo (or Echoes, if multiple being used) is plugged in and connected to WiFi, installing and using the skills is relatively easy. Given that the elderly individuals may not be in the best cognitive state and that their caretakers already lead extremely stressful lives, the proposed solution should not impose a heavy cognitive load on the users. And indeed, the

complete Alexa Eldercare Toolbox can be enabled by simply talking to Alexa and asking her to enable the desired skills, saying, for example, "Alexa, could you enable the night-time-checklist skill for me?"

Once the skills are enabled, they can be invoked by saying something like, "Alexa, start night-time-checklist." Moreover, the cognitive load of needing to invoke specific skills that will be used regularly can be removed entirely by setting up Alexa Routines to launch the skills based on certain triggers, as listed for each of the skills in the "potential trigger" bullets in the previous section. The patient does not even have to remember that the skills exist, as Alexa will, essentially, remember for them.

Despite these pros of the Alexa Eldercare Toolbox, there are some cons that must be addressed. The first and foremost is the potential reluctance of the elderly individuals to accept this new technology into their lives. Integrating new devices into their lifestyle can be daunting and confusing. On top of that, those individuals with Alzheimer's, in particular, might have a very specific routine with which they are comfortable, and introducing a new aspect to that can be confusing, especially when that aspect involves interfacing with a voice with which they are not familiar.

Such a reluctance to accept new technologies is a problem across the entire field of smart eldercare and hence is not unique to the Alexa Eldercare Toolbox. This issue of hesitance might be addressed by having a loved one, someone with whom the patient is comfortable, present as the Echo is set up and then having that loved one interact with Alexa. While there is no guarantee that this will convince the patient, by demonstrating to them that they are comfortable with Alexa, loved ones can help make the introduction of the device as smooth as possible.

If the individual can be convinced to accept the Alexa Eldercare Toolbox as a part of their daily life, there may still be some issues as they attempt to interface with the technology itself, particularly because many elderly individuals are hard of hearing. To mitigate this issue, there are two main routes that can be taken. The first relies upon the type of Echo device installed in the home. The device used for the purposes of this research project was a second-generation Echo Dot, which does not have a screen. However, the Amazon Echo Show is a touchscreen device that provides a visual display. On devices with a screen, closed captioning can be enabled by simply saying, "Alexa, turn on Alexa Captions." With Alexa Captions turned on, Alexa will display her dialog on the screen of the Echo device, helping those who may be hard of hearing.

The second option, which works even if the Echo device installed in the home does not feature a screen, is to hook up the Echo to external speakers. Echo devices can be paired with certain Bluetooth speakers. These external speakers are often able to offer louder sound than the Echo itself, making it easier for the user to hear what Alexa is saying.

From the developer's standpoint, one potential option that could help the hard of hearing would be to integrate videos into the skills offered as part of the Alexa Eldercare Toolbox. Having the toothbrushing skill show a person walking through the steps of brushing their teeth or having the balanced meal builder show examples of foods in each food group on the screen could help patients who might not understand Alexa from her voice alone.

Not only that, but this could also help patients who do not respond well to exclusively auditory cues. In a study conducted by Cathy Bailey and Barbara Haight, it was demonstrated that visual aids could be used successfully to indicate to an Alzheimer's patient the need to complete a certain task [2]. Even more aptly, the Alzheimer's association suggests a "watch me" method for tasks like toothbrushing in which a caregiver demonstrates how to brush their teeth so that the patient can mimic their actions [8]. Videos could easily fill a similar role in situations like this. Plus, videos have the potential to provide images of familiar objects and actions, and for Alzheimer's patients, familiarity means comfort, which, in turn, means a higher likelihood of compliance [13].

Most other major cons with smart home technology are largely related to finance, which, as stated earlier, is less of an issue in this case. However, the one other general smart home problem that should be mentioned is the dependence of the system's functionality on a dependable power supply and internet connection. To prepare for a power outage, one might have generators at the ready and fail over to these devices when the main power source becomes unavailable. Similarly, if one's connection to a WiFi network fails, it would be best to switch the Echo device over to another WiFi network via the Alexa app (an action with which the caretaker might provide assistance), if another network is available, to ensure that Alexa can continue serving without interruption.

VI. Next Steps

While the solution discussed covers a wide range of eldercare concerns as it is, there is still definitely room for improvement. There are several avenues of betterment that could be taken, a number of which are discussed here.

One notably missing feature when it comes to dealing with Alzheimer's patients is some sort of system to ensure that the patient does not unexpectedly wander out of the home. Alzheimer's patients tend to forget where they are, even when in familiar surroundings, like the home environment. As a result, they may get up and wander off, potentially putting themselves in dangerous situations. Danger continues to mount until a caregiver realizes that their patient is gone.

To help prevent this from happening, it would be beneficial to add a wander beacon skill to the Alexa Eldercare Toolbox. For this skill to be useful, though, automation via sensors would be necessary. Namely, a motion sensor would be installed by the exit of the home. This sensor would be connected via Bluetooth to the Amazon Echo device. An Alexa skill would be written to alert the caretaker if the patient left the home unexpectedly. Finally, a Routine would be set up via the Alexa app to launch the wander beacon skill upon input from the motion sensor. It should be noted, though, that the connection between the motion sensor and the Echo device relies upon the built-in smart home hub available in the Echo

Show and Echo Plus. For the purposes of the development of the Alexa Eldercare Toolbox, a second-generation Echo Dot was the only available hardware, hence why this feature remains as an improvement to the system to be made.

From a functional standpoint, new safety skill development is always important in the physical aspect of eldercare. However, from a less functional and more holistic perspective, there is significant room for improvement in making the system more companionable. The overall goal of the Alexa Eldercare Toolbox is to promote wellness, and as much as physical wellness is important, emotional and mental well-being are also critical.

The ideal solution to work toward would be to turn Alexa into a voice companion. Feasibly, this could be achieved by writing lambda code for an Alexa skill that behaves similarly to a chat bot. In order for this to be successful, machine learning would have to be integrated to train the bot to act like a human, a training set would need to be gathered to train the bot in the first place, and persistent storage would need to be implemented to enable Alexa to remember information from the past.

Assuming this could all be done successfully, then users could launch the bot the same way any other skill is launched. It should be noted, though, that this is still not ideal. It is inconvenient, as the user actually needs to start the bot skill any time they want to have a conversation. Remembering to do that may be a challenge in and of itself, so, for the perfect solution, there is some reliance on Amazon itself to make some changes. In the meantime, however, Alexa Routines could be used to configure Alexa to launch the bot skill at times when no other skills are scheduled to be launched. However, this could result in difficulty activating another skill later, if the user forgets that this skill is still running. Additionally, Alexa skills time out after eight seconds of inactivity, so creative time delays would be necessary. In short, this solution is still not ideal, but might be workable and could provide emotional and mental health benefits to the individuals using it.

VII. Conclusion

As the elderly population increases, so too does the need to find means of providing proper care for older individuals. Even though many of these individuals require significant attention, many would prefer to age in place. Additionally, many families cannot afford to place their loved ones in a nursing home or assisted living facility. Together, these two factors mean that many people are turning toward smart home-style eldercare solutions. At times, these can still be expensive, as well as invasive. The Alexa Eldercare Toolbox is proposed as a relatively inexpensive, unobtrusive means of providing care. The toolbox is composed of 13 Alexa skills, several which are specifically geared toward helping those with Alzheimer's, which can be installed by the user in any combination, as needed. The goal of the current set of skills is to help elderly individuals and those caring for them to achieve an overall increase in wellness, and while the skills in this solution are varied as it is, there is still work to be done to improve the toolbox further.

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